FLYING

AND POPULAR AVIATION

Special

ROYAL AIR FORCE

Issue

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CAPTAIN RUDY TRUESDALE, veteran T.W.A. million miler, who flies the sunny Sante-Fe Sky Trail from Kansas City to Albuquerque, makes a business forecast for the future.

"Before Long, Sales and Salesmen Will Be *Going Up* Together.. in the Family Car of the Air"

"MARK MY WORDS," says Captain Truesdale, *"big things are going to happen* in this country after the war. Industry will be producing, and people will be buying, as they never have before.

"You'll be back on the old selling job again, covering your territory in your own Family Car of the Air in one-third the time it takes in a car. And your sa will *go up* because you'll be *going right up* after the Hard to believe? I'd have said so too if I didn't kn the planning that's being done at Cessna in Wichi But now I know that *flying for everyone* is here, rea to be offered as soon as this war's over."

e who can drive an automobile can fly the y Car of the Air. The salesman can use it to ll the small towns the airlines don't reach. And e can use it for 200 mile shopping trips as natu- she drives downtown today. As Captain Truesdale hard to believe until you realize that these predic- e soundly based on Cessna's 31 years of aviation ring and manufacturing background. In addition, all-out wartime production of Bobcats and to help win this war once and for all, is crowding progress into weeks today at Cessna.

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Cessna

SYMBOL OF *Aircraftsmanship* FOR THIRTY-ONE YEARS

We're Wearing War Paint Now

Yes, for the past year and a h Cessnas have been wearing the w paint of the U. S. Army Air Corps the British Empire Joint Trainin Program. And they're going to we that war paint proudly until victo is won.

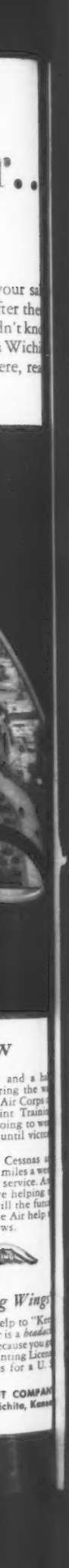
These twin-engined Cessnas flying over four million miles a we in bomber-pilot training service. An just as these Cessnas are helping win the war today, so will the futu Cessna Family Car of the Air help win the peace that follows.

FREE

"Keep 'Em Flying Wings"

Wear your wings and help to "Ke 'Em Flying." Every pair is a *bad for Hitler and Hirohito* because you g them free with a Jap Hunting Licen when you send 10 cents for a U. S Savings Stamp to...

THE CESSNA AIRCRAFT COMPAN Dept. FPA, Box 1616, Wichita, Kans



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What One Student Thinks of PARKS LEADERSHIP TRAINING

A Letter to Oliver Parks, President of Parks Air College, From a 1942 Undergraduate.

Dear Mr. Parks:

I am writing you about the school of tomorrow, my school, Parks Air College. Institutions of this type came into being as the need for trained men in a new industry became acute. It is a young industry, but it is growing fast. I am going to help it grow.

Its name is aviation. It was born 39 years ago on the blowing sands at Kitty Hawk. Since that time its advancement has been breathtaking. There is no need to tell you of present day aircraft. Your own direct connections with aviation throughout its growth have done that. We students love these aircraft and want to spend our lives and talents improving them and flying them.

It takes men to fly airplanes and men to maintain them. For that reason this school was founded. I call it the school of tomorrow. You are training the men of tomorrow. In the brain of the student engineer the planes of the future are already on the drawing board of his mind. All he needs is expert training in the fundamentals and the instinctive inventive genius of the American people will do the rest. The pilots of the future are being trained in this school. They are being taught to fly methodically, carefully, and skillfully. These boys are going to be the "million milers" of tomorrow's airlines.

Aviation demands men who love their work. It is a hard taskmaster and demands the utmost of their abilities and perseverance. It presents a challenge. It needs men who believe in its future and who above all have absolute confidence in the realization of their goal: to personally contribute to the industry so that it will be bigger and better, winning the respect of all.

The men connected with it are always striving to fly a little higher, a little farther, and a little safer. The men in aviation are never satisfied. If they were to become satisfied with their job, the future would become dim. It is that constant striving for perfection and even greater perfection, that insures the future of the young men who are now beginning their work in aviation.

I thought it might interest you to know how one of your students felt about his school and his industry.

Yours respectfully,

PARKS AIR COLLEGE was founded August 1, 1927. Has enjoyed full Federal approval longer than any other aviation school.

Is accredited in its Aeronautical Engineering School by the Illinois Superintendent of Public Instruction.

Included since 1938 in The Directory of Colleges and Universities, issued by the United States Office of Education.

Has a capacity enrollment of 325 commercial aviation students, also detachments of U. S. A. Air Forces Aviation Cadets and Mechanics. Has its own airport with a school plant of 25 buildings devoted to school purposes entirely, also a group of satellite fields for military flight training.

Has a faculty of 104, each especially qualified for his particular field of instruction.

Open to high school graduates with a ranking in the upper two-thirds of their classes.

If you want to know more about the training that inspired this letter to President Parks, send the coupon or a post card request for the new 64-page catalog. It is free.

PARKS AIR COLLEGE
East St. Louis, Illinois

PARKS AIR COLLEGE Section PA-9
East St. Louis, Illinois

Please send me details of four major courses in commercial aviation training.

Name..... Age.....

Address.....

City..... State.....

FLYING
AND POPULAR AVIATION

VOLUME XXXI NUMBER 3 SEPTEMBER, 1942

SPECIAL ROYAL AIR FORCE ISSUE

W. B. ZIFF
Editor and Publisher

B. G. DAVIS
General Manager

MAX KARANT
Managing Editor

DON RYAN MOCKLER
Associate Editor

HERMAN R. BOLLIN
Art Director

GEORGE BERNER
Advertising Manager

H. C. STRONG
Circulation Manager

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MUST LAUNCH 185,000 WARPLANES

The aviation industry is mustering every facility of the world's greatest industrial civilization to fulfill President Roosevelt's far-sighted demand for 185,000 fighting planes. Because the demand exceeds the supply of skilled aircraftsmen, many inadequately trained men are finding single-phase jobs through cheap "quickie" courses. BUT—the vital supervisory positions can only be held by men with the thorough long range training to reach any objective to which they may be assigned . . . the men who have chosen aviation as a career—not an expedient. They are the only men of this huge production army who are indispensable to America's war effort and who will continue to be indispensable when the aircraft industry steps down from war to peace schedules.

The executives who have made aviation THEIR career know the value of each man is governed by two factors: his intelligent sincerity in selecting aviation as his life work, and THE ABILITY AND EXPERIENCE OF THOSE WHO TRAIN HIM FOR THAT CAREER. They know that Curtiss-Wright Technical Institute graduates are—and for many years have been—thoroughly qualified to fill the industry's exacting requirements.

Located in the very center and a very important part of Southern California's great aircraft industry, with its more than two billion dollars in unfilled orders, Curtiss-Wright Tec has come to be recognized as the nation's leading institution for the training of Aeronautical Engineers and Master Mechanics.

Mr. Donald Douglas, President of the great Douglas Aircraft Company, chose this school for his own son's training, which pointedly indicates the high standing Curtiss-Wright Tec has attained in the aircraft industry since its establishment in 1929.

It is imperative that before you invest in a course of career training you determine what the returns will be on your investment . . . for your choice of a school in which to take your training will determine how much money you will make all the rest of your life.

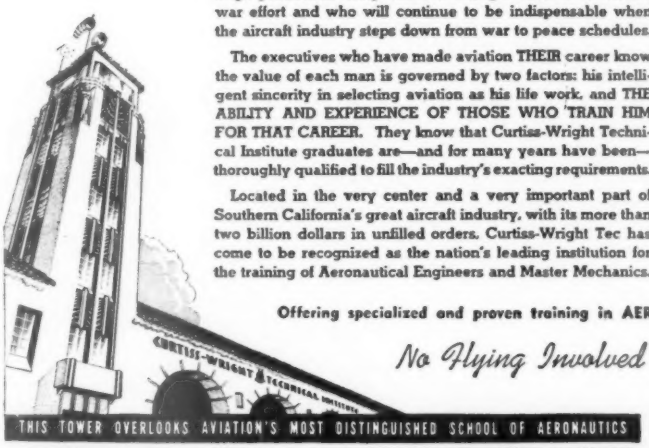
Curtiss-Wright Tec's career training is carefully designed to do just one thing:—TO MAKE MONEY FOR YOU, so upon graduation you can be independent and self-supporting for life. Our thousands of successful graduates have proven that Curtiss-Wright Tec training gets results and always pays, since it trained them in advance for the highest position they could ever expect to occupy. It can do the same for you.

This school has never guaranteed positions for its graduates, but practically every graduate has obtained immediate employment and is advancing rapidly. The demand for our graduates far exceeds the supply, and we honestly believe that every student who enrolls here will be able to obtain, with our assistance, immediate employment upon graduation.

WARNING!—"Don't miss the boat." The greatest opportunity in your lifetime exists today! There never was such an opportunity in aviation for you; there may never be another. A position awaits you. Insure for yourself a steady income and independence for life. DON'T FOLLOW—LEAD! Send in your enrollment before you "miss the boat."

Offering specialized and proven training in AERONAUTICAL ENGINEERING & MASTER MECHANICS

No Flying Involved



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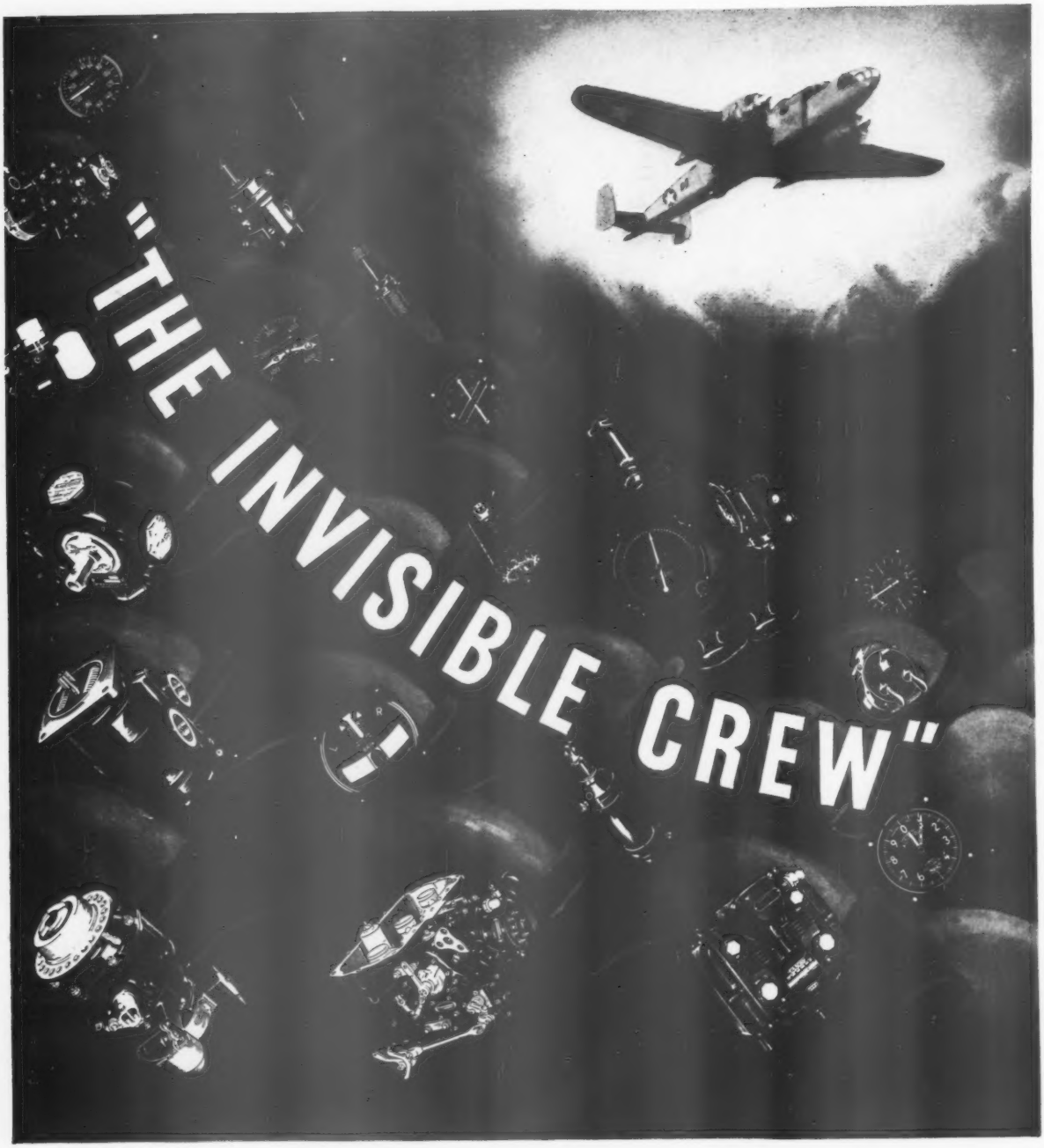

...FIGHTING PARTNERS OF THE ARMED FORCES

THE INVISIBLE CREW
Precision
Equipment by
Bendix
AVIATION CORPORATION

★ Long ago Kendall "won its wings"

Back in the days of the National Air Races, leading aviators recognized that Kendall Oil "had what it takes." For 12 consecutive years it was used by more winning planes than all other oils combined. And today Kendall has proven its ability to stand up under the terrific heat of super-speed, war-time airplane motors. Only the finest quality oil can stand such tests. Kendall is that kind of oil. It is refined from 100% Bradford, Pennsylvania Crude, the choicest in the world. The special refining processes include two used by no other Pennsylvania refiner. Ask for Kendall, the 2000 Mile Oil. Available at most airports.

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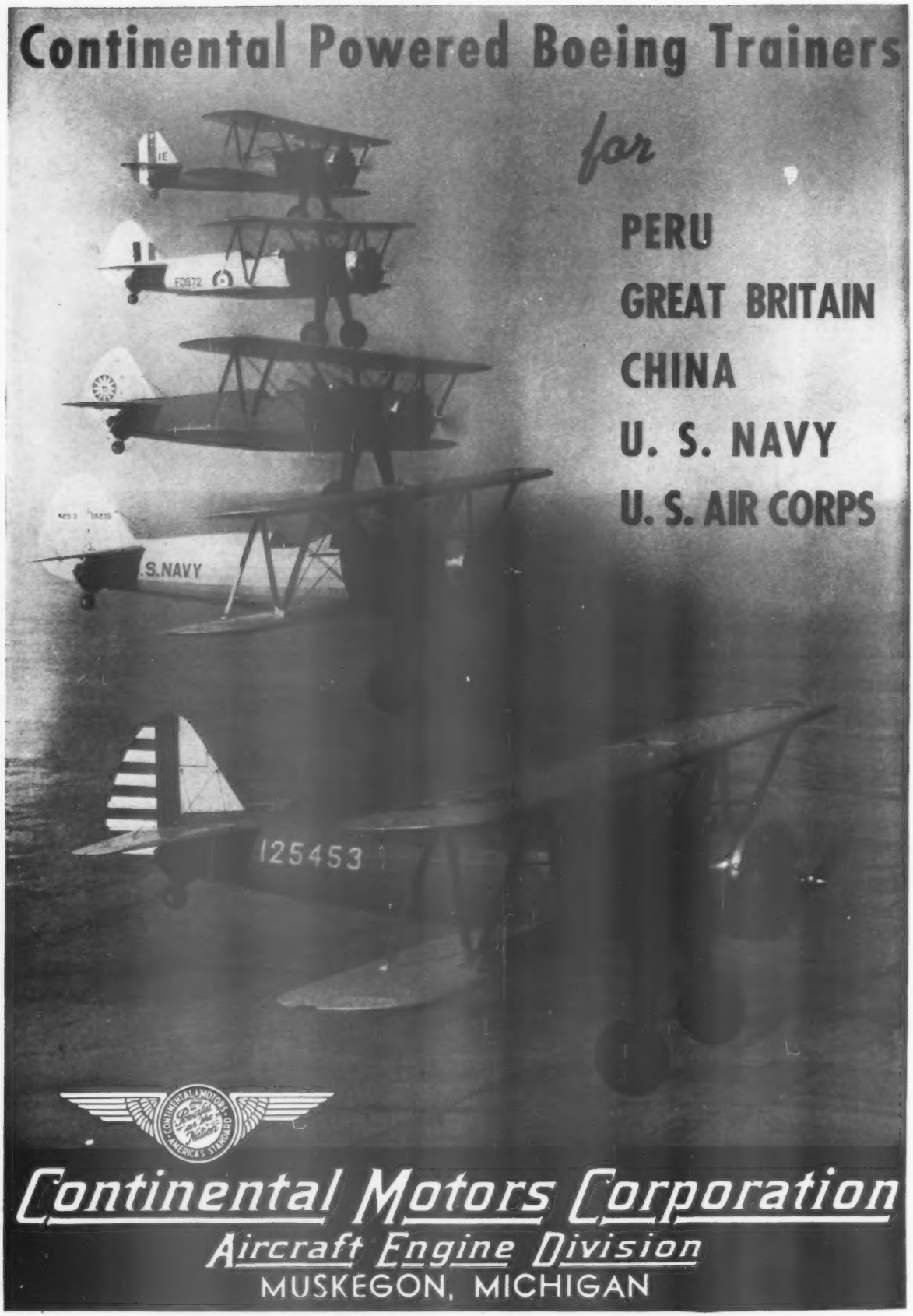
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Battle Proved!
How Goodyear Aircraft Corporation Serves the Airplane Industry
1. By building parts to manufacturers' specifications.
2. By designing parts for all types of planes.
3. By re-engineering parts for mass production.
4. By extending our research facilities to aid the solution of any design or construction problem.
LET'S GO! U.S.A. KEEP 'EM FLYING!
GOODYEAR
GOODYEAR AIRCRAFT

BATTLE-PROOF of the excellence of American airplane design and construction is the oft-demonstrated ability of U. S. aircraft to survive crippling hits and return to their bases even when badly damaged. They can take it, as well as dish it out.

Many of the warplanes now in action on all fronts have major subassemblies built by Goodyear Aircraft Corporation. Our thirty years' experience in aircraft fabrication has proved of inestimable value in meeting the high standards and rigid specifications of these airplanes that are now showing their superiority in the crucible of war.

Today our production of wing, tail, fuselage and cabin sections; flaps, nacelles, floats and other alloy-metal parts; and airships, too, is being increased as fast as new plant facilities and willing hands can accomplish it. A large majority of Goodyear aircrafters have voluntarily pledged themselves to do their part in achieving the nation's goal of 60,000 warplanes this year.

We have pledged, too, that in every part we will maintain the high quality the aviation industry associates with all products bearing the Goodyear name—quality that keeps 'em flying in battle!

The Birdmen's Perch

THE NAMES ARE STILL rolling in for our Oily Boid.

In case you came late—the animated feather duster hopped into the page last month and refused to go away. We gave him a temporary name of "Oily Boid" and asked the Perch Pilots for a better one. We've gotten some daisies, too.

Lubrilark . . .
Strato Sam . . .
Perchawk . . .
Taxi . . .

Tell you what: we'll give an original drawing of the greaseduck to the lad who gives him the best name.

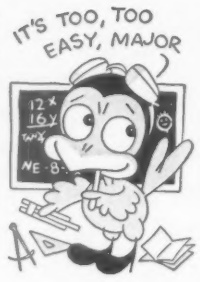
We mean you Perch Pilots on foreign soil, too. Because if you send a better name than the one we pick, any time within the next six months, we'll rename the gashawk and send YOU a drawing. O. K.?

Major Al Williams

alias, "Tattered Wing Tips," Gulf Aviation Products Manager, Gulf Bldg., Pittsburgh, Pa.

BRAINTWISTER

Two plane-owners planned a 720 mile XC trip. Because of engine trouble, one was unable to get off until the other was ¾ of the way to their destination. The late starter used G. A. G., however, and was able to fly 4 miles to every mile of the other pilot. Who got there first? *You* ask and *we'll* answer.



ALLY FORGE

A plane-engine maker is now forging cylinder heads, instead of casting them.

Forging eliminates up to 3½ lbs. of unnecessary weight per cylinder. And each remaining pound of the "cleaned-up" head does an improved, more efficient job, increasing engine hp. output up to 15%.

This forging technique for making cylinder heads might be compared to Gulf's Alchlor technique for making Gulfpride. Both improve over old methods.

Gulf's special Alchlor Process removes "unnecessary weight" in the form of carbon-makers and sludge-formers. Then the remaining "cleaned-up" Gulfpride does an improved, more efficient job of lubricating your engine, increasing its performance.

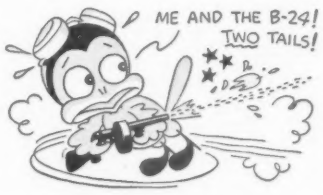
WHOPPER

Dear Major:

Don't put this in the Whopper column—it's true!

This sad tale concerns our late friend, Pilot Officer Elmer Quirk, of Faroff, Tex. It was pieced together from bits of evidence found along the New Brunswick coast, and the undamaged film from his camera gun.

Elmer had just refueled his Howard Mark II (Gulf Aviation Gas, of course) and was on operational training over an undisclosed eastern seaboard city. He must have cracked his throttle and gone into a tight turn. Halfway through the turn, P/O Quirk saw what he thought was the yellow tail of a Jap aircraft. He let go with all guns (one) and watched the yellow tail disintegrate.



While we normally cruise at 150 on ⅛ throttle (using G. A. G.) Elmer must have far exceeded the makers recommendations when he cracked the throttle. Possibly even ½ throttle! The Wasp gave a mighty roar, turned tighter, and poor Elmer shot off his own tail!

L. A. C. Blanchfield H.
L. A. C. Johnson J. F.
#8 S. F. T. S.
Moncton, N. B., Canada

Gulf Oil Corporation and Gulf Refining Company . . . makers of

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NEVER COUNT ON TAIL WINDS ON XC TRIPS. MAKE ALLOWANCES FOR WIND AND HEAD WIND CONDITIONS.
IN CALCULATING FUEL RESERVES, SPACE REFUELING POINTS SO THAT THERE WILL ALWAYS BE —
G.A.G.
G.A.G.
G.A.G.
—A 25% RESERVE IN YOUR TANK WHEN YOU LAND. THAT PROVIDES A SAFE MARGIN AND STILL—
—LEAVES ROOM FOR ¾ OF A TANKFUL OF GULF AVIATION GASOLINE
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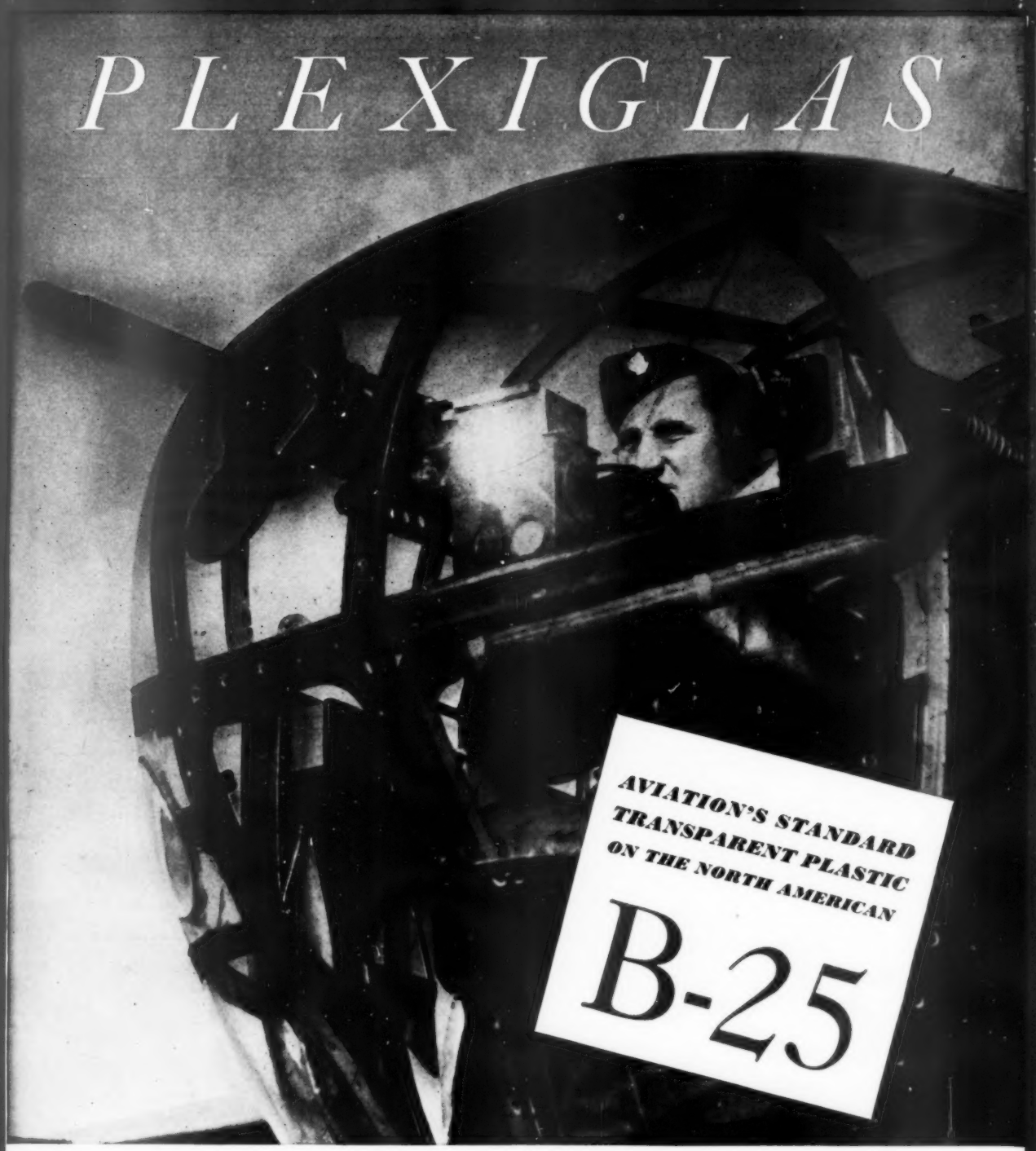
PLEXIGLAS



YOU'VE got to see 'em before you can shoot 'em.

That's the primary reason PLEXIGLAS is used for nose enclosures, gun turrets, observers' domes and other transparent sections on military aircraft. It is perfectly transparent and permanently clear.

Complete protection is important, too, for the gunner must be able to see and breathe and move his gun in the face of a 400-mile-an-hour slipstream. PLEXIGLAS is as strong as spruce, even in the substratosphere.

Combined with these advantages is the ease with which PLEXIGLAS can be formed to streamlined shapes, its light weight, and its ability to yield with the give and take of the plane.

These important properties, proved by six years of active service, have established PLEXIGLAS as "Aviation's Standard Transparent Plastic."

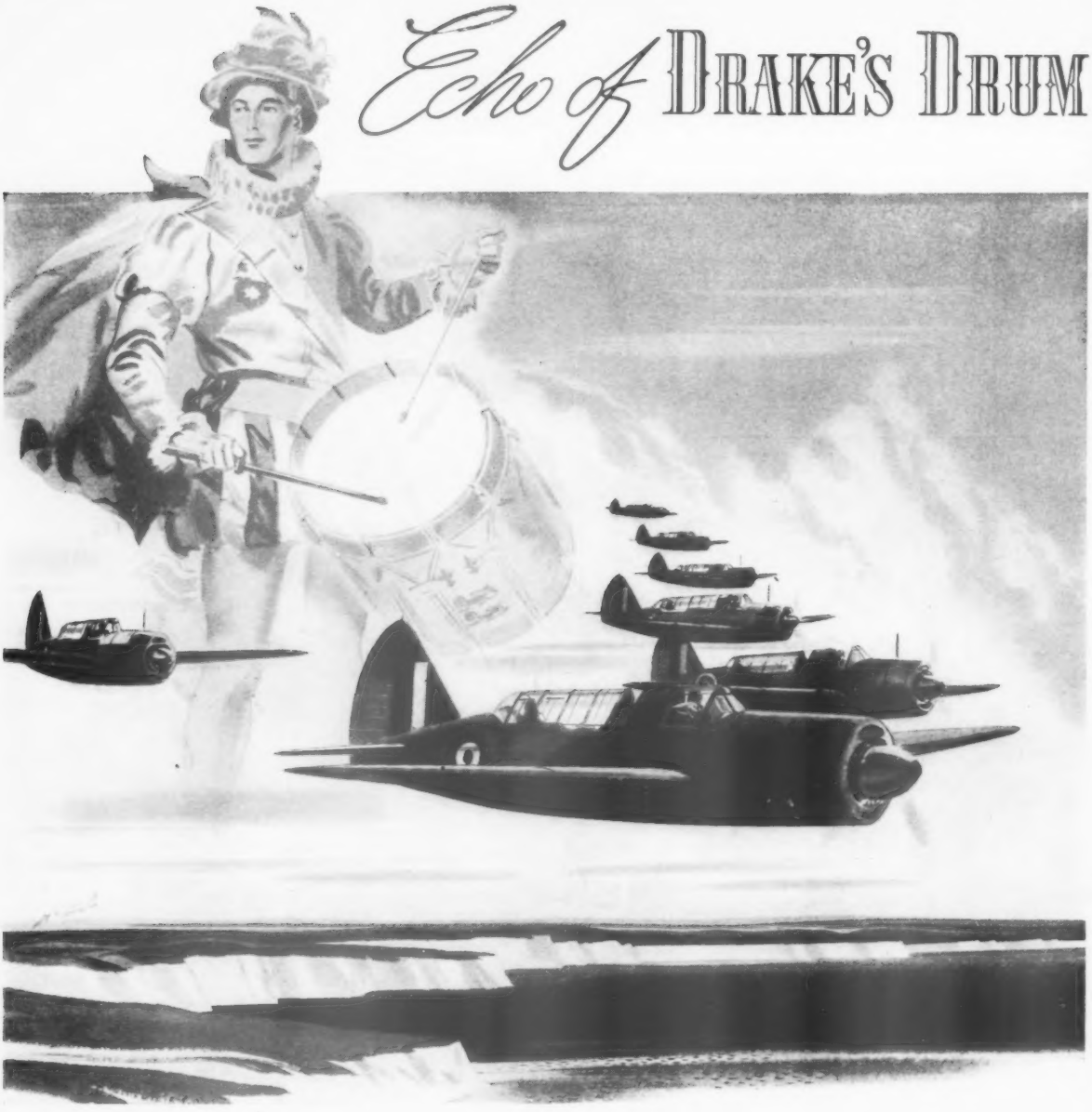
PLEXIGLAS is the trademark, Reg. U.S. Pat. Off., for the acrylic resin thermoplastic sheets manufactured by the Rohm & Haas Company.

ROHM & HAAS COMPANY

WASHINGTON SQUARE, PHILADELPHIA, PA.

Manufacturers of Leather and Textile Specialties and Finishes . . Enzymes . . Crystal Clear Acrylic Plastics . . Synthetic Insecticides . . Fungicides . . and other Industrial Chemicals

Echo of DRAKE'S DRUM



Legend says that the great drum of Sir Francis Drake is heard in a rumbling call to arms whenever Britain's foes beset her. Today the roar of aircraft engines answers the echo of Drake's drum as the forces of the United Nations gather their strength for attack. Flying fleets of Brewster *Bermudas* for Britain and *Buccaneers* for the U. S. Navy are arming the Allies with smashing weapons to blast the enemy.

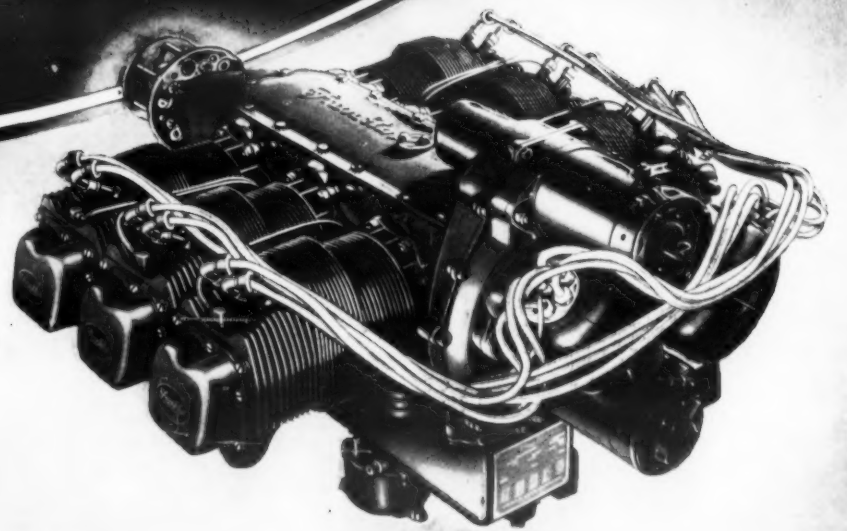
Brewster

FIGHTERS AND DIVE BOMBERS • FOR LASTING MASTERY OF THE AIR

MAKING YOUR

Franklin

SERVE YOU BETTER



OUR interest in the Franklin engine in your plane has only begun when you take delivery. For Franklin recognizes two responsibilities to you. The first is to *build* the most dependable engine that 42 years of air-cooled experience can produce. The second is to keep that engine *serving you well*.

Franklin service stations are strategically located throughout the hemisphere to serve you quickly, expertly and economically. Depend on them for anything from a minor part replacement to an emergency overhaul.

The modern Franklin shops are at your service when you finally need a factory overhaul. They will return your Franklin engine as smooth and powerful as the day you first flew it.

AIRCOOLED MOTORS CORPORATION ★ SYRACUSE N. Y.

Washed out the student but not the WACO

● "The Waco is steady . . . stable . . . strong . . . wide landing gear," says Cannon Aircraft Company. "This one has been dropped into a landing from 30 feet, hitting one wheel, then the other, then the tail wheel. We thought surely the panels would be gone, but no damage. This trick washed out the student, but not the plane."

This is typical of Waco's husky construction . . . particularly important in CPTP trainers, which take a man-handling day after day. The gruelling test of the aerobatics in these training programs has fully demonstrated Waco's reliability—safety—maneuverability. That's why we say—when you think of trainers—think of Waco.

Advanced Flight Instructor T. H. Fowler talks shop with two students at Cannon Aircraft Company.

THE WACO AIRCRAFT COMPANY • TROY, OHIO, U. S. A.

WACO AIRPLANES

1942

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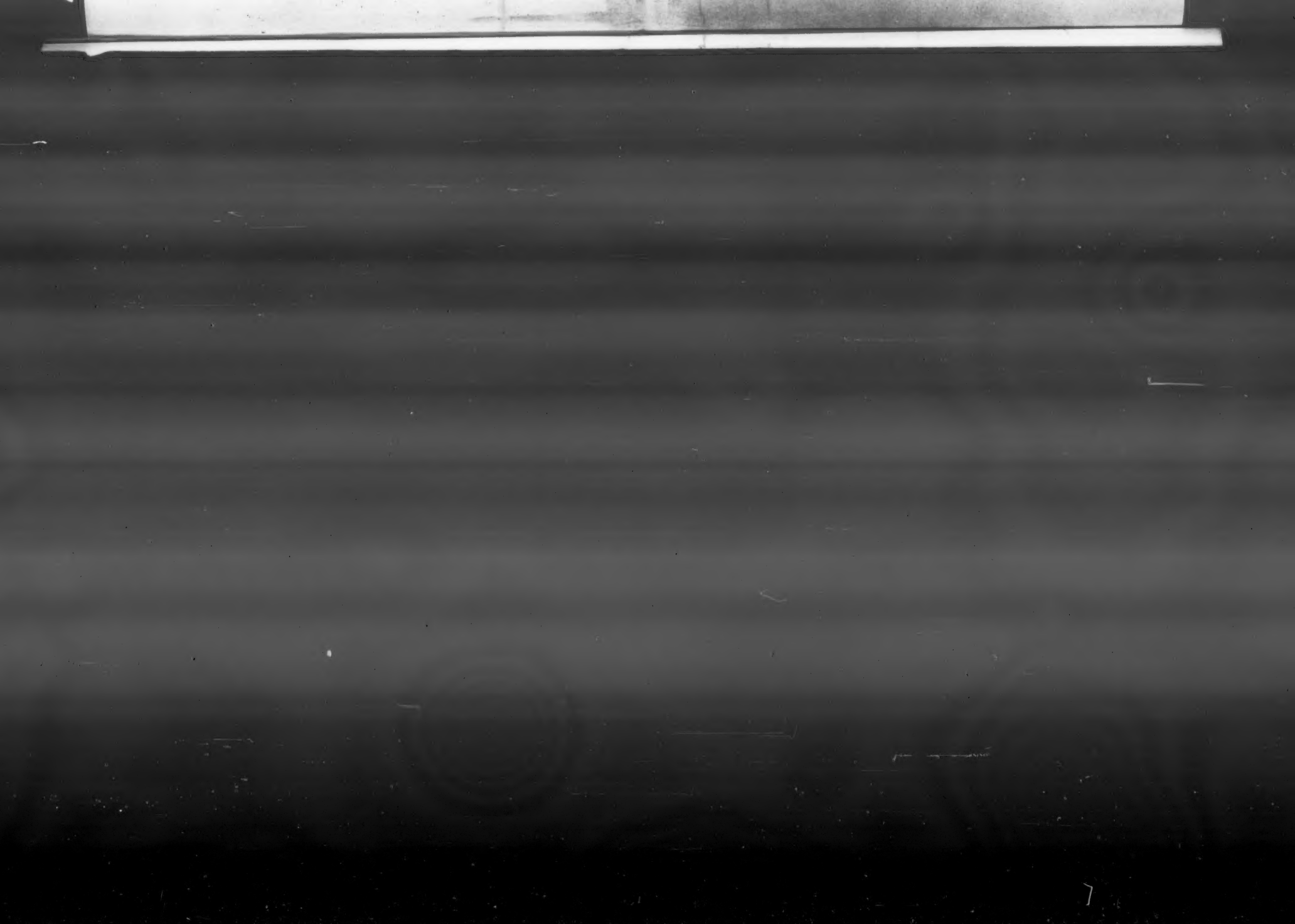
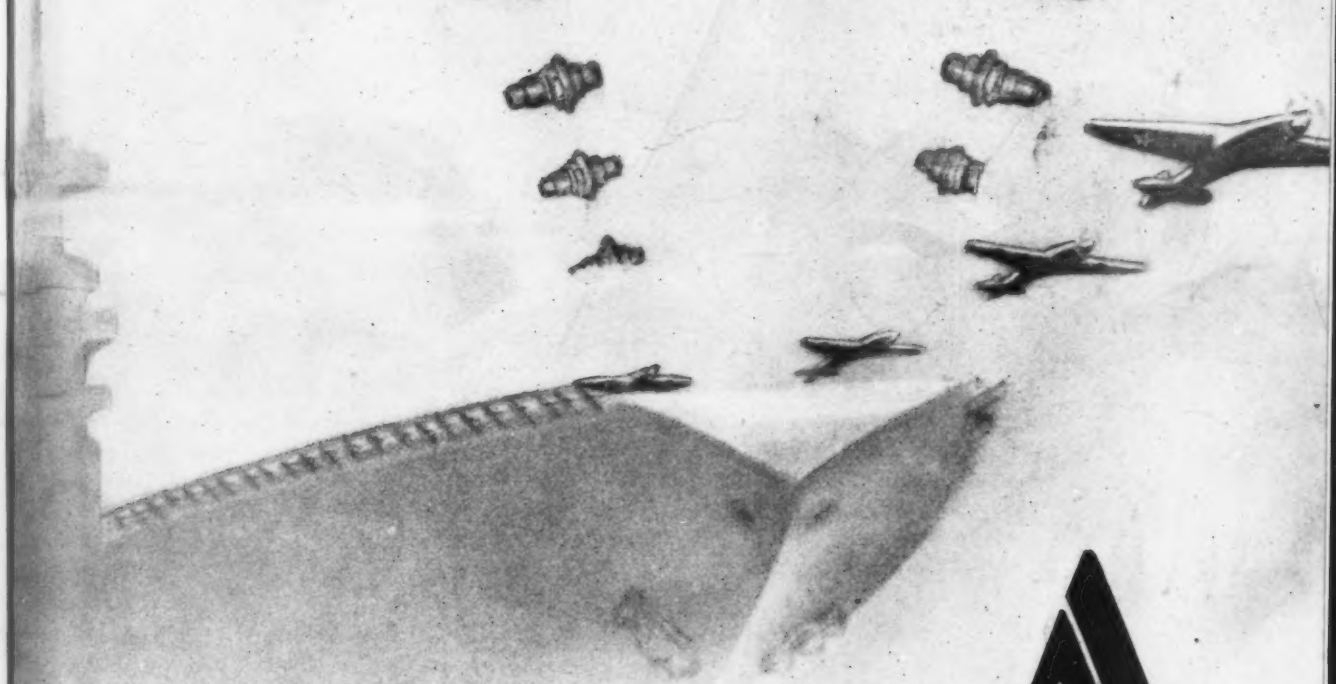
S. A.



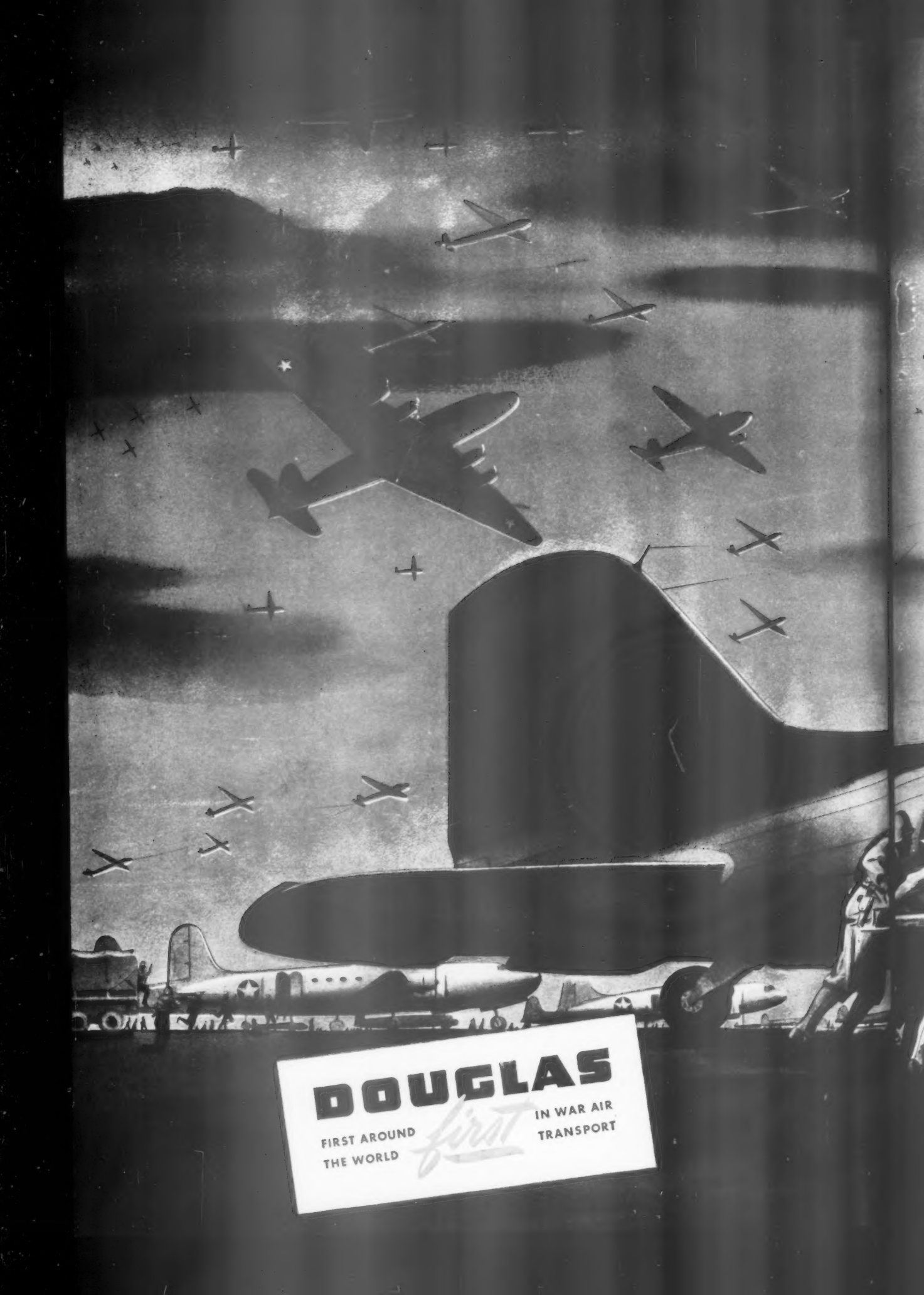
AEROQUIP SELF-SEALING COUPLINGS

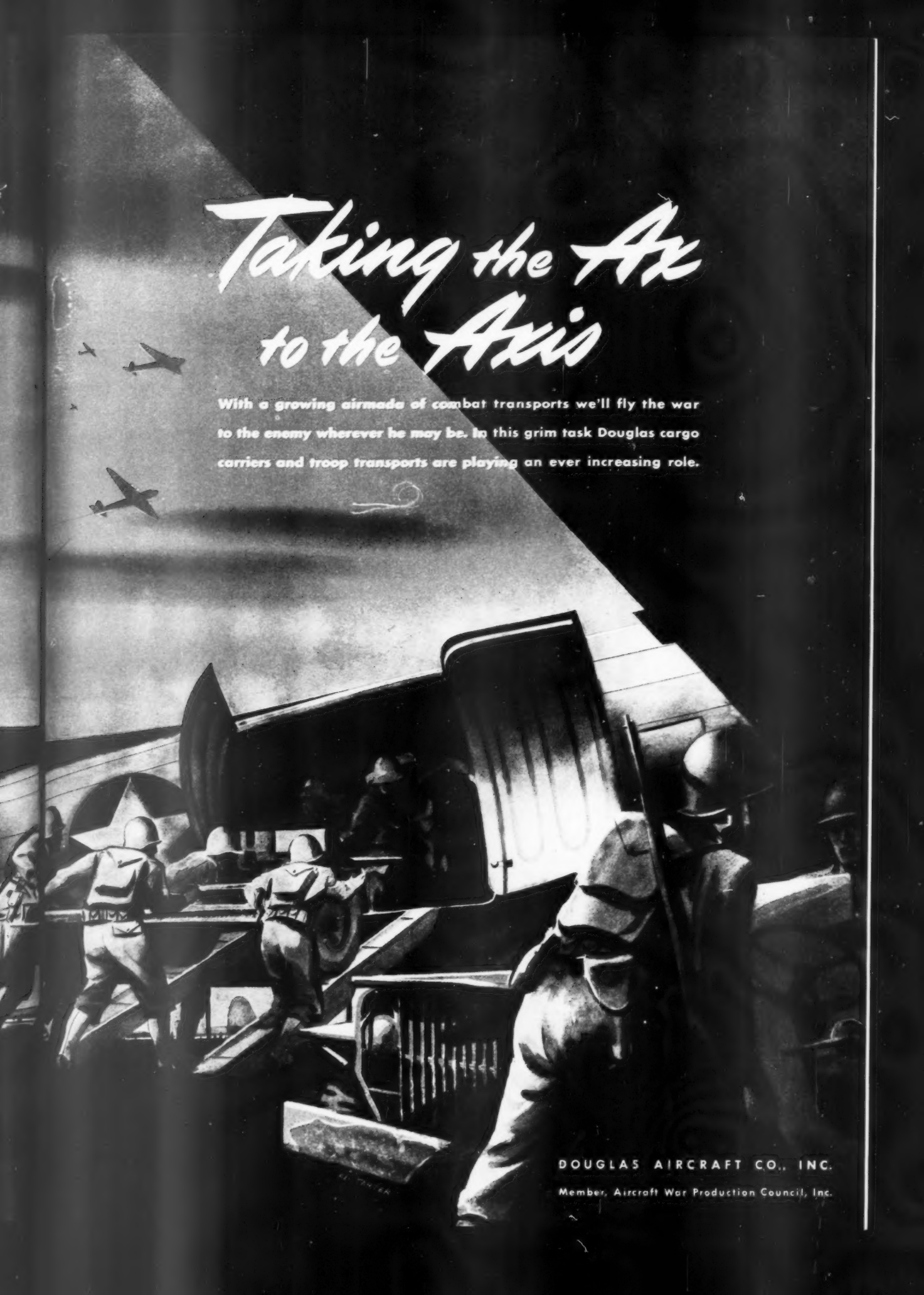
AEROQUIP SELF-SEALING COUPLINGS
ALLOW DISCONNECTION OF
LIQUID CARRYING LINES
WITHOUT LOSS OF FLUID OR
TRAPPING OF AIR
UPON RECONNECTION

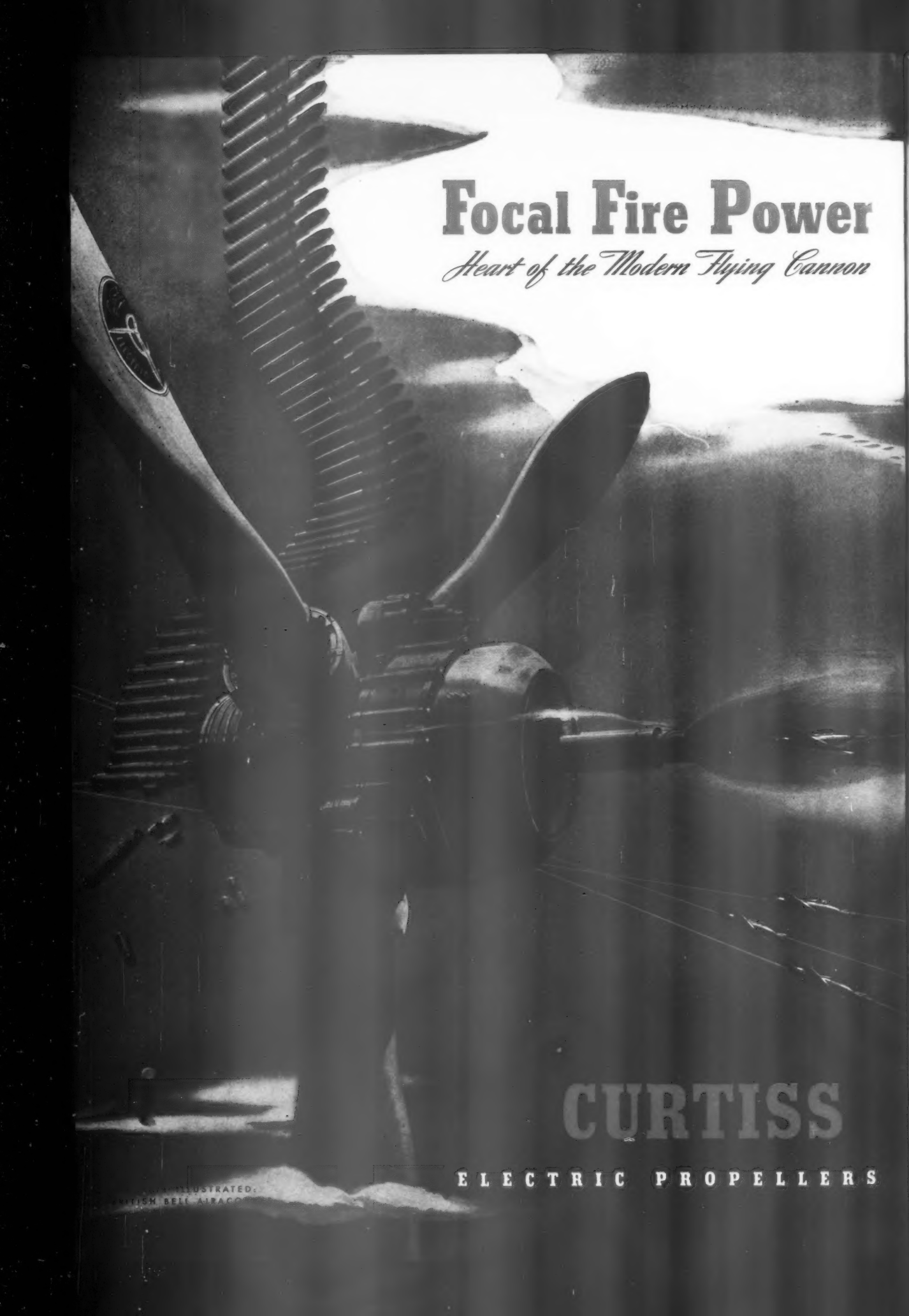


AEROQUIP CORPORATION
JACKSON, MICHIGAN, U. S. A.

AEROQUIP HOSE LINES


DOUGLAS
FIRST AROUND THE WORLD
first
IN WAR AIR TRANSPORT

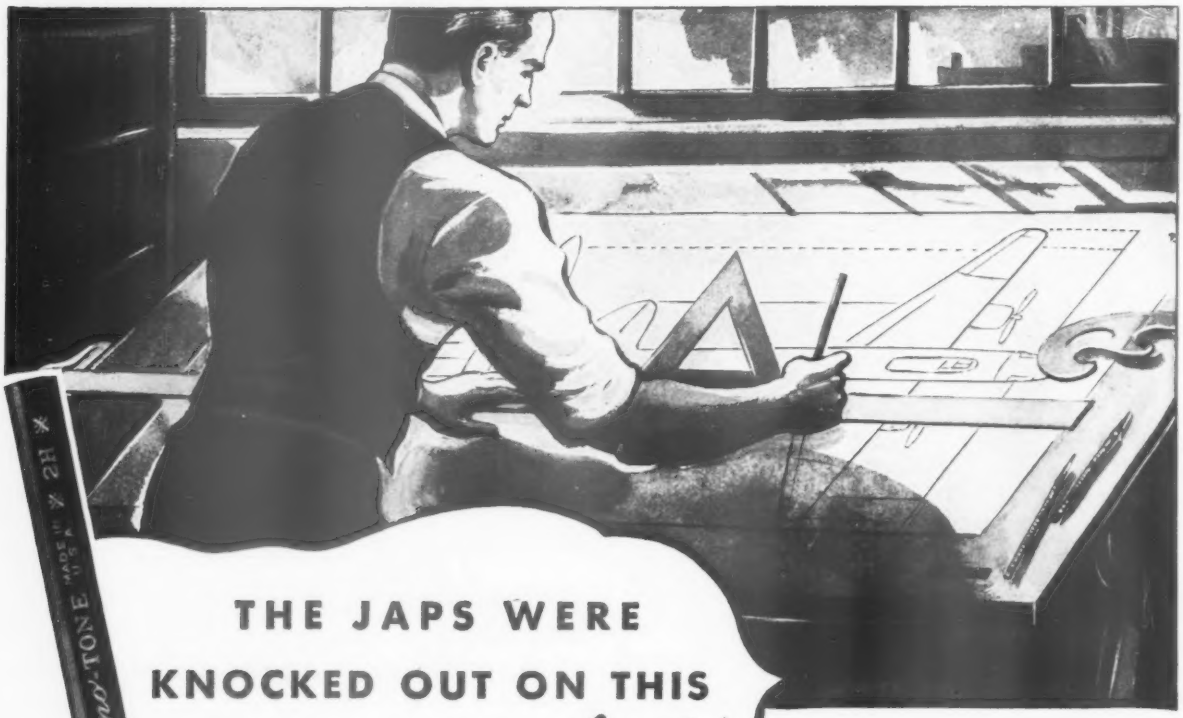

Taking the Ax to the Axis
With a growing airmada of combat transports we'll fly the war to the enemy wherever he may be. In this grim task Douglas cargo carriers and troop transports are playing an ever increasing role.
DOUGLAS AIRCRAFT CO., INC.
Member, Aircraft War Production Council, Inc.


Focal Fire Power
Heart of the Modern Flying Cannon
CURTISS
ELECTRIC PROPELLERS

"SNUB NOSE"... In this war it takes heft to win. The massive visage of the *Republic P-47 Thunderbolt* is a symbol of fighting brawn and rocket speed . . . of terror to Nazi and Jap . . . Republic Aviation Corporation, Farmingdale, Long Island, New York.

REPUBLIC AVIATION

REPUBLIC AVIATION



THE JAPS WERE KNOCKED OUT ON THIS DRAWING BOARD *first!*

BEFORE the little brown men of the Setting Sun were shot out of the skies—they were defeated on this drawing board. Defeated by an army of engineers, designers and draftsmen who make the pencil plans for America's mighty bombers and fighter planes.

Defeated by men whose weapons are brains and pencils—A. W. Faber's WINNER Techno-TONE, America's standard of drawing pencil excellence.

We are proud to contribute this smooth, sleek weapon to the Nation's War Effort—proud to offer a pencil that almost two centuries' experience devised. If you haven't yet used WINNER Techno-TONE we'd like to send you a sample. We want you to discover for yourself how deep-rich, how uniformly unvarying it is in all 17 degrees. Also how toughly resistant to point breakage. Just tell us your favorite degree—that's all. Write Dept. F-9

BUY A SHARE IN AMERICA

WINNER Techno-TONE is available in 17 scientifically graded tones—6B to 9H. Polished rich green. Packed in metal box. Made in U. S. A.

WINNER *Techno*-TONE DRAWING PENCILS

13c each 2 for 25c $1.25 dozen

At all Drawing and Artists Material dealers and leading Stationers.

A·W·FABER·Inc NEWARK, N.J.

Companion Pencil — WINNER Thin Colored Checking — Superb colors and strength. Choicest for all prints: 2381 Red; 2382 Blue; 2383 Green; 2385D Yellow; 2437D Orange. 10¢ each. $1.00 dozen. Would you like a sample?

Selected to Serve

FAMOUS AVIATION NAMES
USERS OF
WITTEK *Aviation* HOSE CLAMPS

BELL
BEECH
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TYPE FB STAINLESS STEEL

WITTEK *Aviation* HOSE CLAMPS

The Standard of the Industry

Designed, built and tested for aircraft use, Wittek Type FB and FBA Stainless Steel Hose Clamps are used by leading aircraft manufacturers, engine builders and commercial airlines as the standard Hose Clamp of the industry.

WITTEK MANUFACTURING CO. • 4305-15 W. 24th Place, Chicago, Ill., U. S. A.

worth waiting for!

Culver, too, has gone into the Service for the duration. ★ But when this war is won Culver will emerge with the *New Victory Model.* ★ Expect this new Culver to be cheaper to own and to fly, and on cross country trips more dependable than anything you have flown. ★ You will not be disappointed. The *Culver Victory Model* is Worth Waiting For!

UNDER CONTRACT TO THE U.S. AIR CORPS

CULVER
AIRCRAFT CORPORATION

CULVER AIRPORT
WICHITA, KANSAS

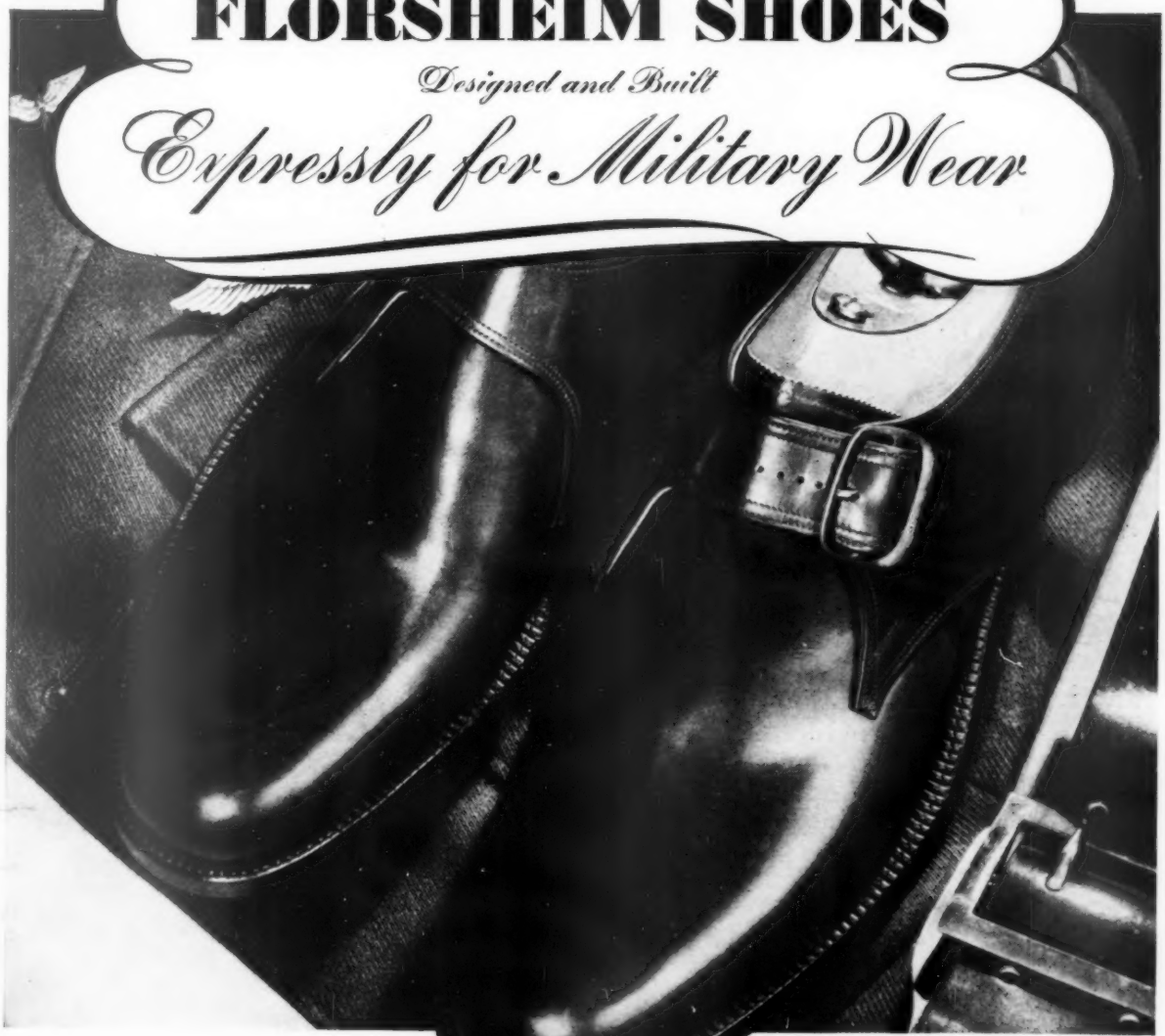
LET'S GO! USA · KEEP 'EM FLYING!

Copyright 1942 by
Culver Aircraft Corp.

FLORSHEIM SHOES

Designed and Built

Expressly for Military Wear



The FLORSHEIM Shoe

We made them at the request of thousands of reserve officers, who were accustomed to the superior fit, comfort, and wear of Florsheim civilian styles. When called up for active duty, they helped us design a special last to meet all Military specifications: straight inside line; extended rubber heel; arch-cradling shank, and seamless, chafeless quarter-linings. This last is now reserved exclusively for Florsheim Military Styles . . . the shoes worn today by more Army, Navy, Marine, Air Corps, and Coast Guard officers than any other Quality line! *Military Style illustrated above,* $11.

WRITE FOR THE ADDRESS OF YOUR NEAREST FLORSHEIM DEALER OR STORE

THE FLORSHEIM SHOE COMPANY • CHICAGO • *Manufacturers of Fine Shoes for Men and Women*

REG. U. S. PAT. OFF.

AIR WING FABRICS

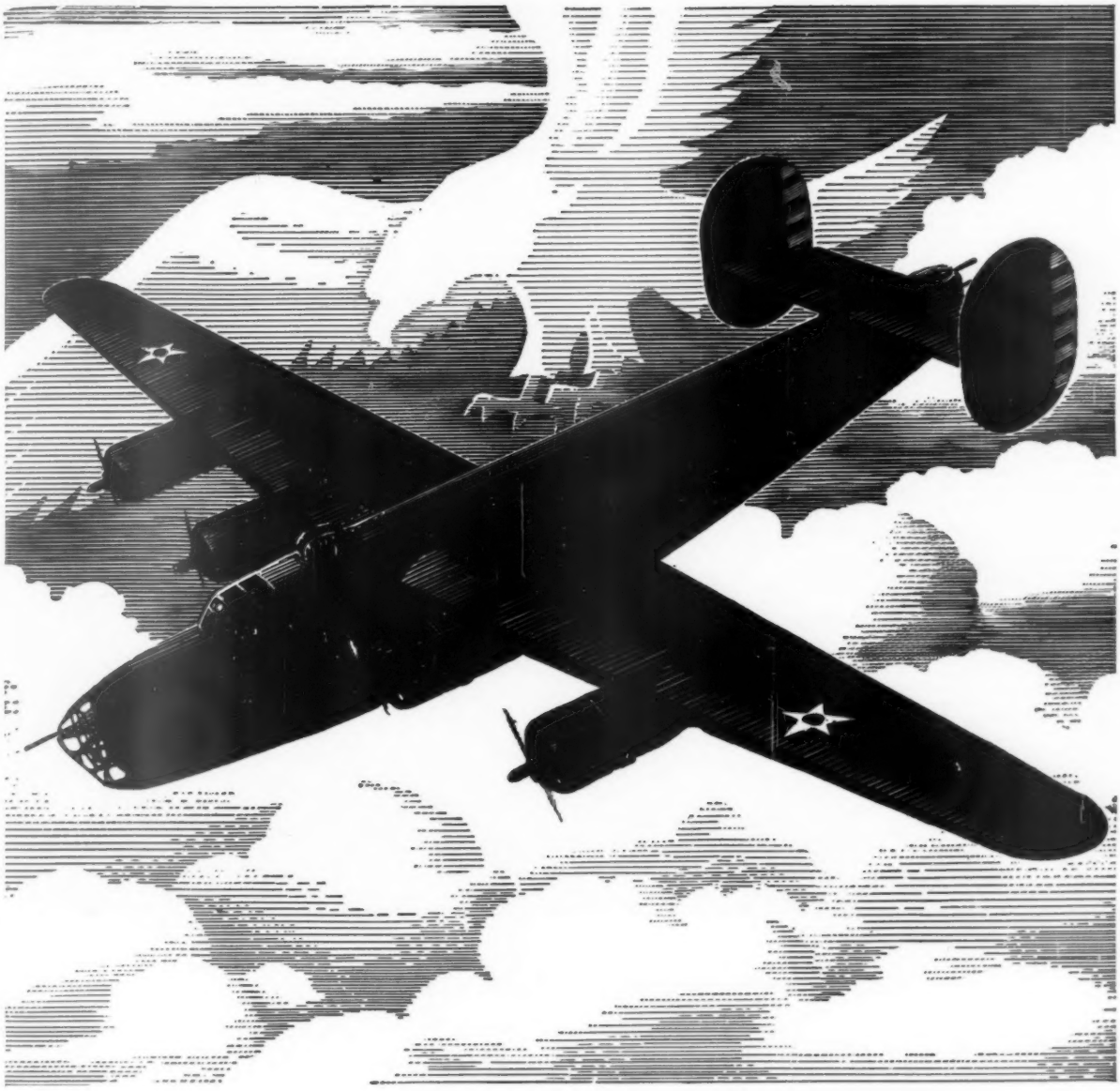
TAPES FOR AVIATION USE

What tapes do you need? Airwing offers you a complete selection . . . pinked edge, sealedge and biased tapes . . . Grade A, light-weight and balloon . . . Utility, reinforcing and herringbone tapes. Airwing airplane and glider fabrics round out the famous Airwing line.

W. HARRIS THURSTON

40 Worth Street, New York City

***Factory and Warehouse*—17 Beach Street, N. Y.**



Now we make it official... *The Liberator*

WE always thought of her by her U. S. Army designation — the Consolidated B-24.

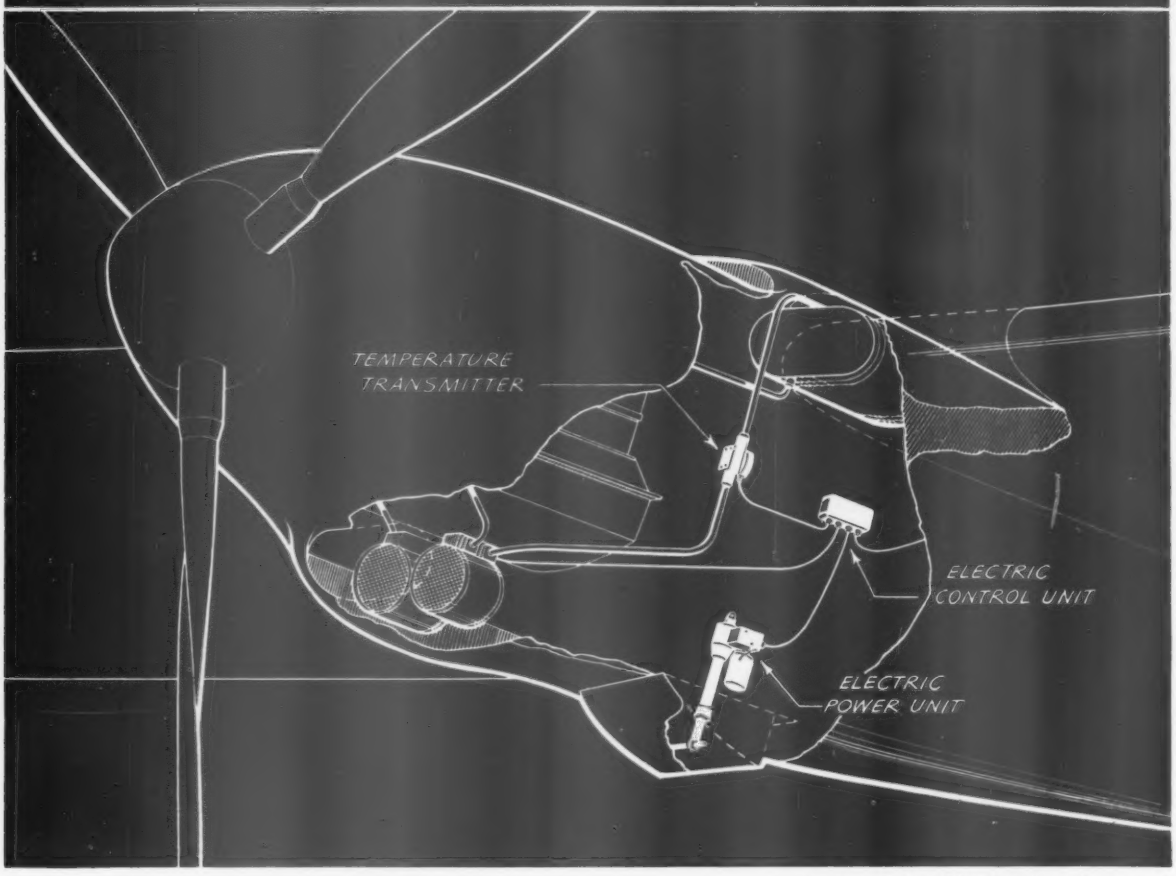
We were so busy setting up the industry's first big-bomber assembly line . . . and passing our mass-production experience on to other manufacturers . . . that we didn't worry much about a name for the B-24.

Then we discovered she had already *won* a name. The British were calling her the Liberator. The American newspapers picked up the name and passed it on to the public. Presently we found that even we ourselves were calling her the Liberator.

So, from now on, Liberator is official. *Consolidated Aircraft Corporation, San Diego, California.*

CONSOLIDATED *builds Battleships of the Air*

Another cut in cooling drag!



—a system designed by aircraft engineers

AiResearch brings you

Automatic Exit Flap Control

1. Closed flaps can often mean 10 to 20 *extra* miles per hour. **2.** Automatic flap control provides plus protection for engines. **3.** Relieving the pilot from manual control allows for greater concentration on gunfire.

To give U. S. military airplanes these three added "edges," AiResearch engineers in cooperation with military engineers have now developed a fully Automatic Exit Flap Control System.

AiResearch's new electrically-operated control system cuts open-flap time considerably, reduces cooling drag. In engine oil cooling, an overriding pressure control supplements thermostatic control, making this the surest-acting system yet developed.

And the simplest. Aircraft engineers designed it to operate without capillary tubes, sylphon bellows or electronic circuits. AiResearch Automatic Exit Flap Controls are easily adapted to every type of airplane . . . may be used on liquid coolant radiators as well as oil coolers.

Successfully flight-tested, this lightweight system is now in volume production. Military aircraft manufacturers may write or wire for details.

AiResearch
MANUFACTURING COMPANY
INGLEWOOD, CALIFORNIA
DIVISION OF THE GARRETT CORPORATION

"Where Controlled Air Does The Job" • **Cabin Pressure Regulating Systems** • **Prestone Radiators**
Engine Oil Cooling Systems • **Engine Air Intercoolers** • **Supercharger Aftercooling Systems**

B-24E, "Liberator" now produced by Consolidated and Ford, is fabricated with Boots Self-Locking Nuts

HOW BOOTS NUTS SPEED ASSEMBLY ON THE LINE AT WILLOW RUN

Speed and more speed, without sacrifice to quality—that's the battle cry on the production front today. And that is one reason why Consolidated's great B-24E, now in quantity production at the Ford Company's new Willow Run Plant, is assembled with Boots Self-Locking Nuts.

These ingenious fasteners not only cut assembly time; they are, in addition, lighter, safer, more permanent than old-fashioned nuts.

Because they are lighter, they allow for as much as 60 pounds greater fuel or ammunition capacity on the B-24E.

Because they are safer, there is no danger of loosening by vibration.

Because they are more permanent, they literally "out-last the plane."

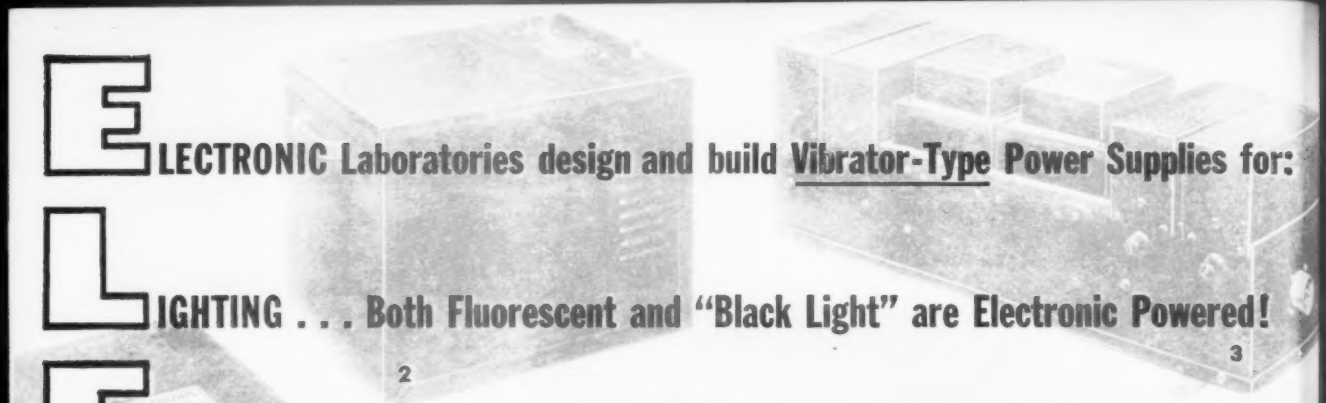
Boots one-piece, all-metal, self-locking nuts pass the rigid test of the Army, Navy, and Civil Aeronautics Authority.

BOOTS

Self-Locking Nuts For Application In All Industries

Boots Midget Anchor Nuts are a recent development, embodying the Boots Self-Locking principle. Specifically designed for application where space is limited. Write for new catalogue . . . Correspondence should be directed to General Office, not to factories.

BOOTS AIRCRAFT NUT CORPORATION ★ GENERAL OFFICES, NEW CANAAN, CONNECTICUT



ELECTRONIC Laboratories design and build Vibrator-Type Power Supplies for:

LIGHTING . . . Both Fluorescent and "Black Light" are Electronic Powered!

2 3

EMERGENCY Power for radio and electrical devices!

—Vital at Airports! Lighthouses! Coast Guard! Telephone Exchanges!

1

COMMUNICATIONS . . . Marine, Police, Amateur Radio Networks

—depend on Electronic Power Supplies!

TANKS! Jeeps! Walkie-Talkies! Planes! PT-Boats! 6

—These are but a few of Electronic's military applications!

RELIABILITY proven daily by Allied Armed Forces!

—frequencies absolutely constant and stable!

4

OUNCE-SAVING Electronic Power Supplies are trusted flight companions

—in both military and civil aircraft.

5

NEW current capacities! NEW flexibility in input and output voltages!

INGENUITY and Resourcefulness are outstanding characteristics of the . . .

7 8

CUSTOM Engineering Service which Electronic invites YOU to use.

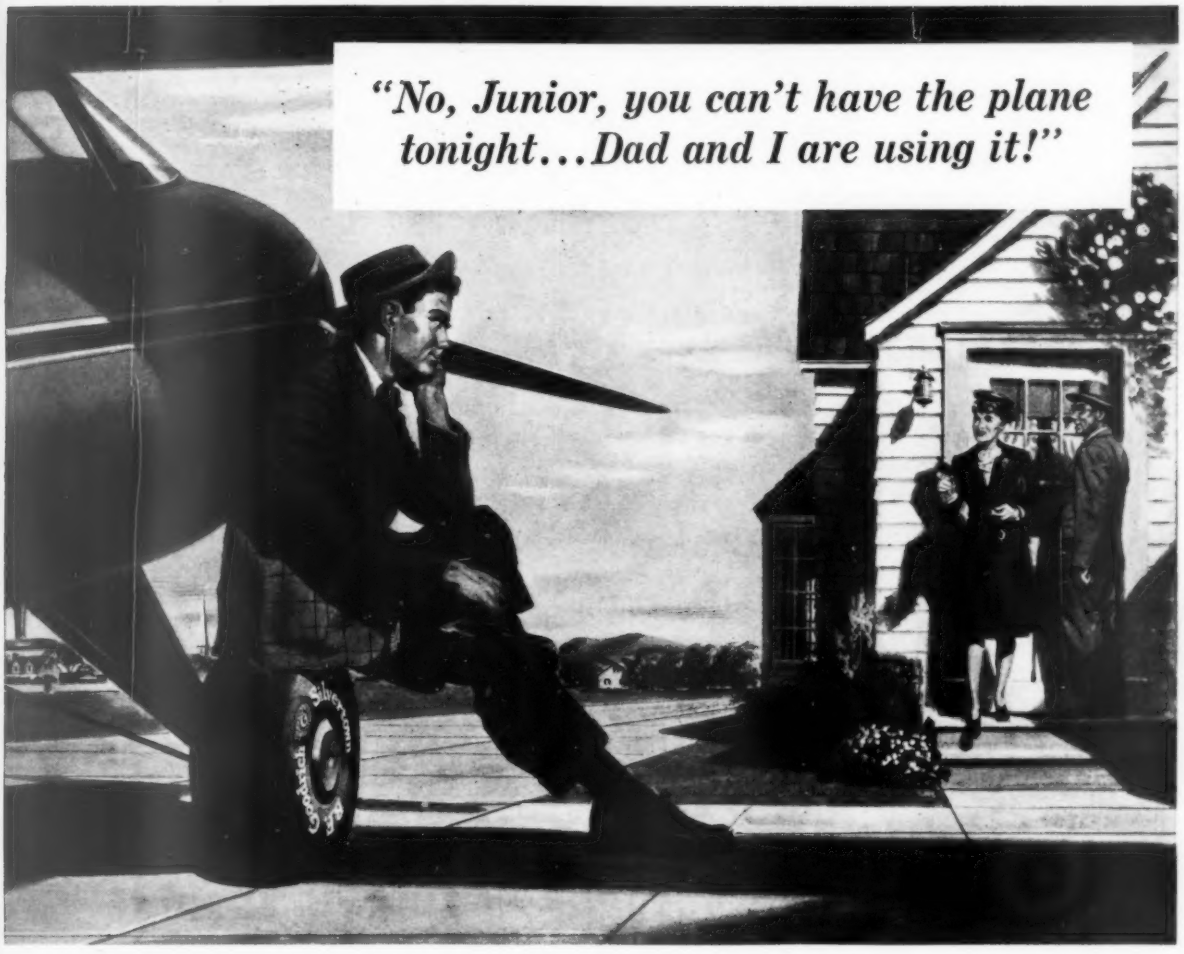
1. Operates electric razors in trains and planes.
2. Portable source of 110 AC power.
3. More important than the bombs in a bomber.
4. Controlled variable frequency for most exacting timing requirements.
5. Battery-operated 400-watt AC Transmitter-Receiver Power Supply.
6. Ounce-saving unit for "Black Light" on planes.
7. AC and DC input and output FM Power Supply.
8. 12-Volt Heavy-Duty Power Supply, Output 425 Volts at 225 Milliamperes.

The above illustrates typical types of Electronic Converters. Recent military applications not included.

ELECTRONIC LABORATORIES, Inc., INDIANAPOLIS, INDIANA

for power supplies *remember* ELECTRONIC

S



DON'T feel too sorry for Junior. Life in the America that lies ahead has other compensations. In fact, it will be so far superior to what his parents had at his age, their fondest hopes will seem meagre, their deepest dreams will seem trivial.

For ours is a land that sets its future by the stars themselves. Even with a war going on, we who live here can see the shape of things to come.

It's not hard to imagine a family plane. Many were flown before the war. American manufacturers have blueprints of them for larger production when peace comes. It's not hard to conceive of hourly air travel to distant continents. Our ferry command is doing just that today. It's not hard to believe in fleet upon fleet of flying freighters when we're turning out gigantic bombers by the thousands right now.

Is this new America a dream? Yes, in the sense that its wonders reach into the depths of man's imagination. No, in the sense that it is real and inevitable. For the men who are planning and building the planes of Victory *now* will soon be planning and building the planes of Peace.

Out here at B. F. Goodrich our Aeronautical Division has been making dreams come true for over 30 years. We've played our part in the miracles of aviation with Silvertown Tires that make a plane's landings safer with Expander Tube Brakes that give pilots greater ground-control, with De-Icers that defy the elements.

Naturally, most of the 80 B. F. Goodrich aviation products we turn out today are used by Uncle Sam—on his bombers, fighters, training planes.

We're proud of this. Every B. F. Goodrich employee knows that what he makes goes to create a plane that is the world's best. One reason he's doing his job today faster and better than ever is that he too wants to get started building the new America. The B. F. Goodrich Company, Aeronautical Division, Akron, Ohio.

HERE ARE SOME FAMOUS AMERICAN FIGHTING PLANES THAT ARE SUPPLIED WITH B. F. GOODRICH EQUIPMENT

You CAN AUTOGRAPH THIS BOMBER!

Every few minutes (our enemies would like to know *exactly* how often), another airplane is completed at one of North American Aviation's great plants.

Sometimes, one of our workers gives it a personal finishing touch. He paints on the fuselage a single parting word—"Tokio," "Berlin" or his own initials.

We want *you* to be as proud of these planes as we are at North American. We'd like to put your name on one of these planes because *you're* helping to pay for it by buying War Bonds, and by paying taxes.

Here's how you can autograph one of the planes pictured above: Mail us a penny postcard, with your name *and the serial number of the next War Savings Bond you buy.* Address North American Aviation, Dept. H, Inglewood, California. And we'll write your name on a plane destined to smash the Axis.

Perhaps your name will go on a North American B-25 Bomber like the first Army plane that sank a U-boat in the Atlantic, and first carried the war to Tokio.

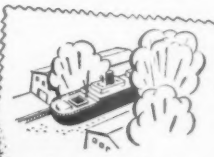
Perhaps your name will fly with a deadly North American fighter, like those that have downed Messerschmitts and Jap Zero fighters alike.

We want *you* to feel the same glow of pride we feel, every time another plane rolls off the production line. We want *you* to be a member of North American's team.

You are the men and women we're working for, because *you* are the United States of America—130,000,000 strong . . . fighting, saving, and working together to do history's biggest job.

NORTH AMERICAN AVIATION, INC.
Main Plant, Inglewood, Calif.

NORTH AMERICAN Sets the Pace

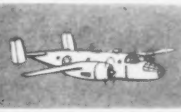


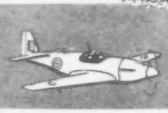
FIRST to bomb Jap positions in the Philippines were North American B-25s.

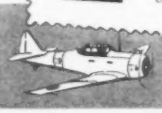
FIRST to deliver a plane under National Defense contracts.

BONDS BUY BOMBERS!
When you buy War Savings Bonds you're buying planes for victory. Buy Bonds each payday!

JOIN THE ARMY OR NAVY AIR FORCE







the United Nations B-25 (the "Mitchell") ★ For U. S. Army and RAF "Mustang" ★ For U. S. Army AT-6A . . . For U. S. Navy SNJ-3 . . . For RAF "Harvard"

A *blind cockpit*

BLAZED THE TRAIL TO TOKYO!

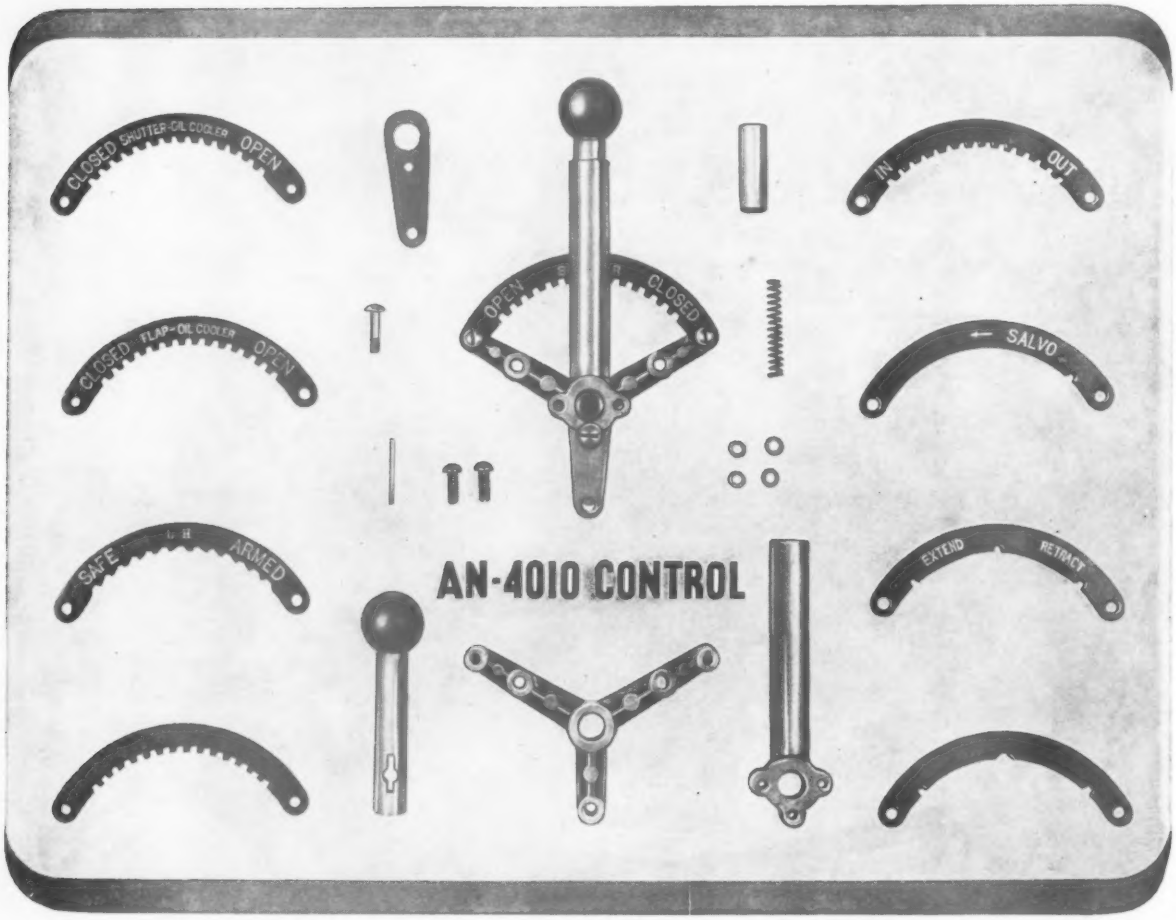
WHEN his General's stars were Lieutenant's bars, one of the Army's most famous fliers climbed into the canvas-covered cockpit of an old biplane and made the first successful "blind" flight in the history of aviation.

By that flight he proved that precision aircraft instruments are the *signposts* of the skies!

Thirteen years later, these *signposts* guided him through the night to the island that "couldn't be bombed." And when his boys had given the Nips a taste of their own medicine, took him safely home again.

The Kollsman Sensitive Altimeter made practical that first flight by instruments alone . . .

Just as, years later, along with other Kollsman Instruments, it helped point the way on the round trip to Tokyo.



AN-4010 Shutter Controls

The illustration above shows the many possible adaptations for controlling flaps, bomb racks, tail wheel locks, landing gears, etc. This particular assembly AN-4010 can be shipped promptly as this control is now in continuous production . . . Hyland has been manufacturing precision aircraft products for 12 years. All Army and Navy specifications are rigidly enforced in the manufacture of each and every product.

We also invite your inquiries for AN-486 and AN-481 clevises, rod end terminals, clamps and clips

HYLAND MACHINE COMPANY
DAYTON, OHIO

HMC

AERONCA

FIRST AND FINEST ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

In these historic days when the borders of the world are re-shaping, literally overnight, domination of the skies means the difference between conqueror, and conquered. ☆ ☆ *Supremacy in the air begins with efficiency on the ground, and neither sun, nor rain, nor enemy fire halts the Air Forces' nimble-fingered mac's in their task of "keeping the boys upstairs."* ☆ ☆ ☆ *From Pursuit and Interceptor Units—from Bomber Groups—from their eagle nests aboard swift carriers, these service crews put 'em in the air and—send 'em back again—again—and again.* ☆ ☆ ☆ *Aeronca is proud of its responsibility for delivering to our Armed Forces planes to their specifications, built solely to standards of "First and Finest." But for minor adjustments or major overhaul, we depend on and salute, the lads "who keep 'em flying." The Aeronca Aircraft Corp., Middletown, Ohio, U. S. A.*

The Aeronca Victory Award

The Aeronca Aircraft Corporation pledges its entire resources of equipment and experience to produce only the finest in material and manufacture for the men who are privileged to fly for their country. ☆ ☆ ☆ ☆ *The—Aeronca Victory Awards—presented to employees for skill that develops better products or creates time-saving operations—are our dedication of an "all out" pledge to win the war in the shortest space of time.*

AERONCA

POLARIS FLIGHT ACADEMY

LANCASTER CALIFORNIA

Now the R.A.F. shifts from gallant defense to swift attack, and in the forefront are pilots who received their training at Polaris — just as Cal-Aero and Mira Loma graduates are making history with the United States Army Air Force. For the duration of the present emergency these great schools will continue to devote their entire efforts and modern airport - academy bases at Ontario, Oxnard and Lancaster, California, exclusively to the training of Aviation Cadets for the United States Army Air Force and the Royal Air Force.

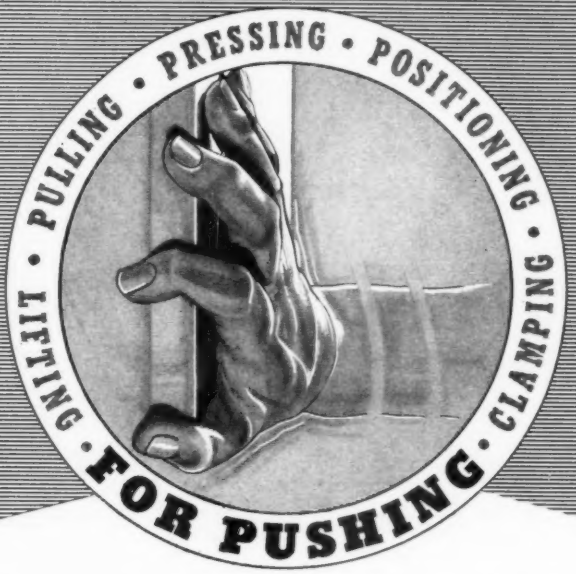
CAL-AERO FLIGHT ACADEMY

ONTARIO · CALIFORNIA

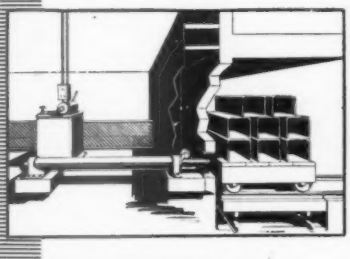
MIRA·LOMA FLIGHT ACADEMY

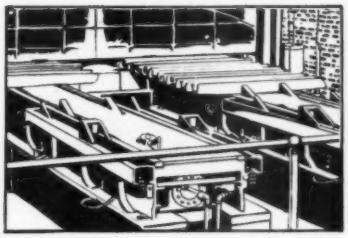
OXNARD · CALIFORNIA

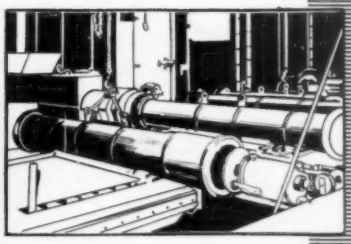
INDUSTRY'S NEW RIGHT HAND



Industry is swinging more and more to a new way of tackling production problems — writing new answers to its needs for power, speed and control. It is viewing HydrOILics in its real light: a *new right hand* that packs higher efficiency into a wide range of industrial operations . . . an industrial tool that utilizes the basic advantages of *oil* as a medium for transmitting power and motion.







Take **PUSHING** operations as one example. In ceramic plants HydrOILics eases ponderous, ware-loaded cars through tunnel kilns at split-second *constancy* of speed, regardless of variations in the load. Yet the speed of these car-pushers can be varied infinitely, to meet the exact requirements of any processing need.

And in the metal industry, HydrOILics pushes heavy steel billets through heat-treating furnaces with the ease of a baker pushing biscuits into an oven.

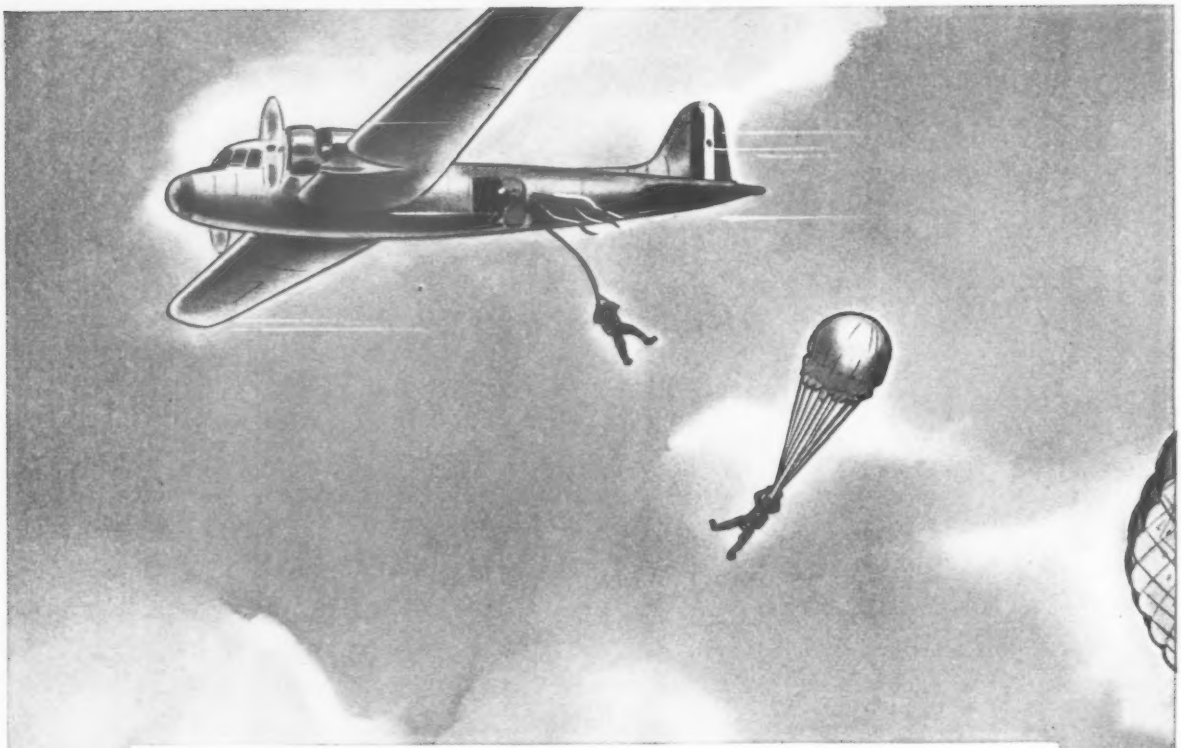
HydrOILics takes jobs like these in its stride—pushing, pulling, pressing, positioning, clamping and many others.

On another ceramic job, HydrOILics pushes mixed clay under tremendous pressures through steel cylinders and into automatic machines that form dishes at high speeds. HydrOILics feeds the clay into the machines at just the right speeds — faster for saucers, slower for plates — does it with tons of power under hair-line control.

It does them *better* because it delivers more *flexible* power, speed and control. Denison HydrOILic engineers will be glad to show you where HydrOILics can improve your production set-up. You won't be obligated by writing; or if you prefer, call your Denison representative. The Denison Engineering Company, 1170 Dublin Road, Columbus, Ohio.

WHEREVER YOU NEED **POWER-SPEED-CONTROL** CHECK ✓

DENISON EQUIPMENT *in* APPLIED HydrOILics



"GERONIMO!"

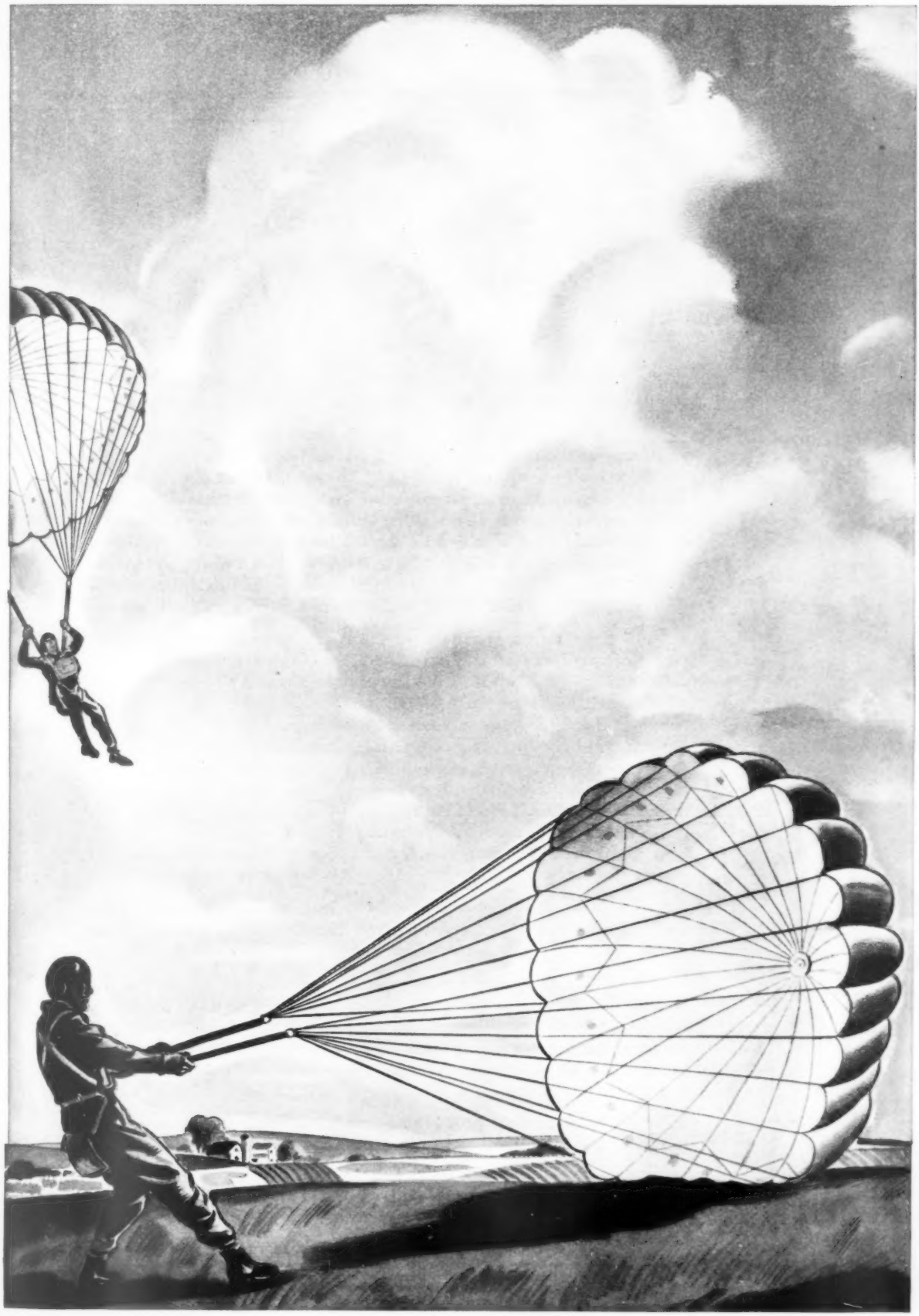
Every piece of Airchox Coined Parachute and forged Harness Hardware is manufactured from specially rolled steels to the exacting specifications of the U. S. AIR FORCES.

AIRCHOX COMPANY

8 So. Michigan Ave. CHICAGO

The following manufacturers of parachutes for the U. S. AIR FORCES use AIRCHOX FITTINGS

American Lady Corset Co.
Atlantic Parachute Co.
Cole of California, Inc.
Eagle Parachute Co.
Federal Parachute Co.
Hayes Manufacturing Co.
Irving Air Chute Co.
J. G. Menihan Corporation
National Automotive Fibres, Inc.
Pioneer Parachute Co.
Reliance Manufacturing Co.
Standard Parachute Co.
Wm. E. Wright & Sons Co.



Introduction

This special issue of FLYING presents the first authoritative account to be published in this country of the British Royal Air Force.

When the annals of our times are finally written and recorded in the history books, it will be discovered that during the early period of this bloodiest of all wars it was the RAF which was the front line of defense not only for Britain but for civilization itself. Without these daring and gallant modern knights of the skies, Britain and a woefully unprepared America would have been overrun by the barbarian hordes. Long night would have settled over the world. The Battle of Britain which was fought by the brave men of the RAF and which stayed the advancing legions of the Nazi, will prove to have been one of the true turning points of history.

The thrilling exploits of the RAF's bomber command in its gigantic forays over Germany have been a notable element in bolstering the defense of Russia, compelling the Luftwaffe to dissipate its strength over a wide area. It offers a great promise, too, for the future. Wherever these planes of the RAF are is the second front. Soon the big *Lancasters* and *Stirlings* will be joined by powerful American four-engine types. Soon great squadrons of American airmen will be flying side by side with their comrades of the RAF. Riding with these young heroic figures, who represent the finest young manhood of the two great English speaking nations, will be the hopes and future of a free world. It is these young airmen who will fight the battles of Germany and Japan, who will determine the issue and give us victory.

It is hence important to all Americans to know and understand the RAF—its history, its character and constitution, as well as its exploits. These are the things by which the world of tomorrow may live.

This analysis has been especially prepared by the British Air Ministry for the information of Americans associated with the war effort. It presents extensive new information together with pertaining illustrations. Rather than a mere record of operations it offers a picture of the organization of the RAF as a whole and of its achievements in general after more than three years of war.

We are indeed proud to be the vehicle by which this memorable record of a great fighting organization is made available to the public.

William B. Ziff

Editor and Publisher, FLYING

Foreword by

THE RT. HON. SIR ARCHIBALD SINCLAIR, Bt., K.T., C.M., M.P.

Secretary of State for Air

I DEEM it a privilege to contribute this foreword to the Royal Air Force number of FLYING which gives so impressive a picture of the Royal Air Force at war and of the Dominion and Allied squadrons fighting by its side.

I hope that this issue will be widely read, not only for its stories of adventure and courage but for what it tells about the Royal Air Force as a fighting machine, the tactical and strategical conceptions underlying its operations, the almost incredible variety of its tasks and the detailed organisation which sustains its endeavour.

It describes, I think, a Force well-equipped, highly trained, soundly organised and efficiently administered, a Force young in years, yet with epic traditions which inspire the highest confidence and promise.

The Royal Air Force owes much to the United States which, to supplement increasing production here in Britain and in the Dominions overseas, has sent us many fine aircraft. They have been put to excellent use.

And now we are to have the honour of receiving your Air Force's squadrons to fly with us in battle. We salute them. They will have great occasions and—we may be sure—their deeds will shine in lustre on the scroll of fame.

I write this at night, and Britain lies outwardly at peace under a full moon while a thousand British bombers spread destruction in the heart of Germany. The contrast with those nights, scarcely more than a year ago, when we ourselves were grimly on the defensive, is deep and significant.

Now, in these islands, long the bastion of democracy, the spirit of attack surges strong as the armed might of the United Nations prepares for the close assault. And in the struggles that lie ahead, our combined Air Forces in gathering strength will smite the enemy, hip and thigh, until victory is won.

Archibald Sinclair

AIR POWER IN WAR

by Portal.

The importance of air superiority in land and sea battles, as well as in aerial encounters, has been clearly shown by victorious record achieved through air power in this war.

AIR CHIEF MARSHAL SIR CHARLES PORTAL, G.C.B., D.S.O. AND BAR, M.C., CHIEF OF THE AIR STAFF, was born in Berkshire, England, in 1893. He received his education at Winchester and Oxford. In 1914, Sir Charles joined the Royal Engineers as a despatch rider. In 1915, he became an observer in the Royal Flying Corps, and before the end of the war had received the M.C. and the D.S.O. with Bar. In 1935, he became an instructor at the Imperial Defence College and in March of 1940, he became Commander-in-Chief, Bomber Command, soon after was appointed Chief of Air Staff.

THE conquest of the air has revolutionised the art of war. It has changed the whole way of life of every combatant people. These facts were widely recognised before the outbreak of the present war. Most of the countries of Europe, feeling themselves threatened by the ever more aggressive attitude of Nazi Germany in the late 1930's, organised air raid defence measures on a large scale. Indeed, the possible consequences of air warfare to the civil population seem to have been more clearly foreseen than the effects of the use of air power on the development of warfare as a whole and in particular upon the tactics of the naval and military forces of belligerents. Those responsible for the equipment and conduct of the armed forces of a great state must necessarily move with caution, for complete defeat may be the dreadful price of a mistake. That is why, as Admiral Mahan points out in a famous passage, the application of newly discovered weapons is almost invariably slower than the potentiality of those weapons would warrant. There are dangers in technical conservatism as well as in experimentation, and victory may reward that nation which most rapidly adapts the theory and practice of its armed forces to the use of some crucial new weapon. Germany gained devastating successes at the beginning of the present war, successes which brought her within an ace of final victory, before effective resistance could be organised. That she made a fuller use of the air weapon than any of her opponents was one of the main secrets of her success.

Owing to her slowness to rearm, Great Britain began the war against Nazi Germany in an air inferiority of one to four. Not only could the Germans put four aircraft into the sky for every one which could be flown by the RAF, but the RAF were also compelled to continue using large numbers of aircraft which were already obsolescent. In the months preceding the war the most strenuous efforts had been made to provide us with modern aircraft. These efforts, as all the world knows, bore fruit just in time to turn the tide at a later stage in the war, but at first the RAF possessed only a fraction of the resources required to guarantee the security of Great Britain. On the one hand, our force of fighter aircraft was inadequate for the air defence of the most vital objectives in Britain, including London, the largest and most vulnerable target for air attack in the world. On the other hand, we possessed a totally inadequate striking force of bombers with which to hit back at the enemy.

It is important to emphasise these facts today, not in order to revive dead controversies, but to explain the conditions under which the RAF has had to work in the past and under which to a considerable extent it still works. Our air resources have never approached our requirements and we have therefore had to decide how best to distribute what we have. Naturally, the first need has been to defend our base. Not only is the security of this country vital if the war is to be continued in Europe at all, but it was essential to ensure that production was not unduly interrupted in what is one of the main sources of supply of armaments to the United Nations throughout the world. We have therefore had to concentrate on the building up of our fighter force and of Coastal Command, which assists the Navy in the vital work of keeping open the sea lanes to this country. Then, after the entry of Italy into the war, we had to build up strong forces in the Middle East to prevent the enemy overrunning Egypt and securing access to all the Middle Eastern countries and the Indian Ocean, which form one of the main bastions in the defence of our Empire.

We could not be strong everywhere. All we could do at first was to ensure that we were strong at the essential points and we had to accept that this could only be achieved at the expense of weakness elsewhere. Our relative weakness was accentuated by the strategical advantage possessed by the enemy with his central position and short lines of communication.

As a result we have met with many grave reverses which have given rise to severe criticisms of the RAF. To our great regret we have been unable to provide the air forces required in all places throughout the world and have thereby exposed land and sea forces to fighting under the disadvantage of inadequate air assistance. Unfortunately this has been inevitable. If we had dispersed our resources more than we have done we should have been weak everywhere and we should probably by now have lost the war.

I am glad to say that the situation is now quickly improving. On the one hand, Germany has undertaken a great new campaign against Russia involving the dispersal of her air resources over a very large area and the addition of the powerful Soviet Air Force to the strength of the United Nations. On the other hand, large numbers of aircraft which have for some time been flowing to the RAF from the American factories are now making their weight felt. These factors, coupled with our own efforts, are bringing us rapidly to the time when the United Nations will have decisive air superiority over the Axis in all parts of the world.

The importance of air superiority in battle was realised by many before the war. Our experience has shown it clearly for

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THE ORGANISATION OF THE ROYAL AIR FORCE

The British have found a successful formula for the separate, but not independent, conduct of its Army, Naval and Air components.

by

C L Courtney

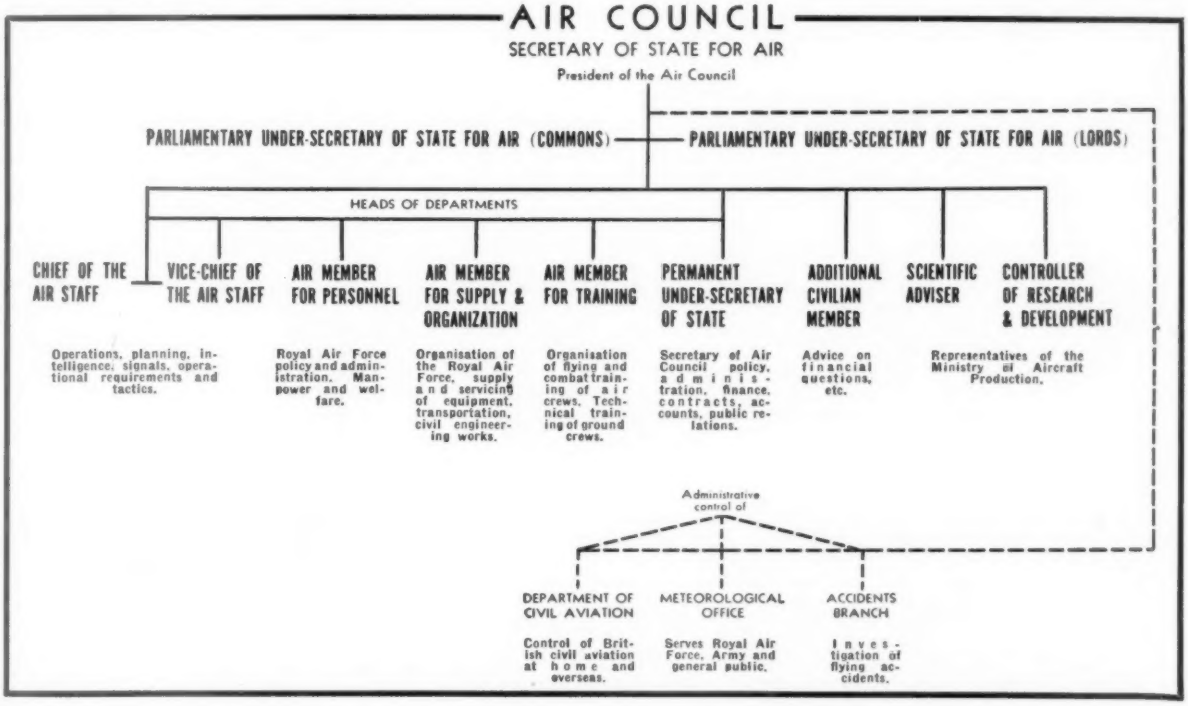
AIR CHIEF MARSHAL SIR CHRISTOPHER LLOYD COURTNEY, K.C.B., C.B.E., D.S.O., Air Member of the Air Council for Supply and Organisation since January, 1940, has held the posts of Deputy Director of Operations and Intelligence at the Air Ministry, and Director of Training. In 1912 he joined the Royal Naval Air Service and since has received commissions in all three fighting services. He was awarded the D.S.O. in 1917, for services as Wing Commander at Dunkirk. His Royal Air Force service includes periods of duty in India and Iraq. In 1938-39, Sir Christopher was a member of the Chatfield Expert Committee on the Defence of India.

THE Royal Air Force organised as a separate service, equal in status to the Royal Navy and the Army.

There has been much discussion, both in Britain and in America, whether the aircraft possessed by a nation should be organised in this way or, alternatively, whether they should be used as components of the Army and Navy respectively. It is not the purpose of this article to enter into any controversy. It is for each country to decide for itself how best to organise and employ its resources of aircraft. All that is attempted here is an entirely factual statement of how we in Britain organise and employ our aircraft in order to meet the conditions and tasks with which we are confronted. Our island situation, our world wide commitments, our proximity to the European continent—all these conditions create problems peculiar to ourselves.

Although the RAF is a *separate* service, it would be a great error to describe it as an *independent service*. None of the three branches of the armed forces, the Army, Navy and Air Force, *can* be independent of each other. They are rather interdependent forces. It would be disastrous if any one of them attempted to wage war on its own. Their task is rather to wage a joint and, so to speak, three dimensional war; or rather perhaps to wage one war simultaneously in the three spheres of land, water and air. It is seldom realised that it is precisely because we are so profoundly convinced of its interdependence with the Navy and Army that we consider it indispensable to maintain the cohesion and unity of the Air Force. We are convinced of the necessity for the three services to throw their combined weights into joint operations. And it is only a centralised Air Force which can use its whole strength in combined strategical employment with the Army or Navy, or both, in successive campaigns or operations.

The technical consideration which lies behind this cardinal fact of modern strategy is this. The main mass of our operational aircraft must consist of fighters and bombers which can be used successively for many different purposes. This versatility and flexibility is the supreme characteristic and necessity of the air arm.


AIR COUNCIL
SECRETARY OF STATE FOR AIR
President of the Air Council
PARLIAMENTARY UNDER-SECRETARY OF STATE FOR AIR (COMMONS)
PARLIAMENTARY UNDER-SECRETARY OF STATE FOR AIR (LORDS)
HEADS OF DEPARTMENTS
CHIEF OF THE AIR STAFF
Operations, planning, intelligence, signals, operational requirements and tactics.
VICE-CHIEF OF THE AIR STAFF
AIR MEMBER FOR PERSONNEL
Royal Air Force policy and administration. Manpower and welfare.
AIR MEMBER FOR SUPPLY & ORGANIZATION
Organisation of the Royal Air Force, supply and servicing of equipment, transportation, civil engineering works.
AIR MEMBER FOR TRAINING
Organisation of flying and combat training of air crews. Technical training of ground crews.
PERMANENT UNDER-SECRETARY OF STATE
Secretary of Air Council policy, administration, finance, contracts, accounts, public relations.
ADDITIONAL CIVILIAN MEMBER
Advice on financial questions, etc.
SCIENTIFIC ADVISER
Representatives of the Ministry of Aircraft Production.
CONTROLLER OF RESEARCH & DEVELOPMENT
Administrative control of
DEPARTMENT OF CIVIL AVIATION
Control of British civil aviation at home and overseas.
METEOROLOGICAL OFFICE
Serves Royal Air Force, Army and general public.
ACCIDENTS BRANCH
Investigation of flying accidents.

Let us consider the bombers. The uses to which a force of bombers can be put are various. It can be used, for example, to attack by land or sea the communications of an enemy force engaged with our own land forces. We use our bombers for this purpose when we attack the lines of communication of Rommel's forces in Africa. But we also use our bombers to attack the German productive system in the cities of Germany itself.

Yet during the very weeks when we were conducting heavy raids on Germany, identically the same bomber force was switched for two nights to a purely Naval target. They attacked the German naval concentration, including the battleship *Tirpitz*, at Trondheim. These same bombers could have been, and some of them were, over Rostock attacking the Heinkel works on one night of the week, over Trondheim another night; and by the end of the week were attacking other targets in Germany like Kiel or Cologne. Is it not clear that if, say, a third of our bombing force were permanently attached to the Navy, a third to the Army and a third reserved for the bombing of German targets, an enormous waste of effort would result?

But there is an even more basic principle involved. The preliminary and continuing necessity in every air operation is to gain and maintain air superiority. This can only be done by the destruction or neutralisation of enemy forces, either in the air or on the ground. When once that air superiority has been won, and so long as it is maintained, aircraft of many kinds can be used to attack the enemy's ground forces, his lines of communication and his Naval units and thus give decisive help to the Army and Navy. If, on the other hand, an attempt is made to divert too many aircraft to these specialised tasks to the detriment of the effort required to gain and maintain air superiority, then air support cannot be given because the supporting aircraft are prevented from operating and are shot down. Specialised Army or Navy co-operation aircraft are not well suited to engage in the struggle for air superiority and need bomber support and fighter cover just as much as any other land or sea forces engaged with the enemy.

This is one of the lessons of the Battle of Britain, when the German air force strove in vain to gain this indispensable air superiority over these islands. Because the German air force never gained it, the formidable military undertaking of an opposed landing on our shores across the English Channel (the first obstacle which held up the German panzers) could not be launched; and, it is not too much to say, the world was saved. On the other hand once air superiority has been won many types of aircraft can be used for a number of purposes. An example is afforded by our Bristol *Beaufighter*. Originally designed and extensively used as a long range fighter especially for operation over the sea, the *Beaufighter* came to play a central part as a night fighter in the defence of our cities against the German raider. And finally, in Libya, once the indispensable prerequisite of air superiority had been won Naval type *Beaufighters*, originally sent from Coastal Command for Naval co-operation, were used with great effect (they have a heavy armament of both cannon and machine guns) for the ground straffing of enemy troops and transport. They could not have been used in this way had the main force of short range enemy fighters remained effective.

But, it may well be asked, are there no types of aircraft so specialised that they can perform one, and only one, specific task? Yes, there are such completely specialised aircraft and we have made provision for them in our system of organisation. While the main force of bombers and fighters is capable of undertaking many functions and can be turned at will from one task to another, yet we have various types of aircraft which can be used only in one particular way; and these aircraft are organised accordingly.

An example of such specialised aircraft are those which, hitherto, have operated from aircraft carriers. These are generally of special design to enable them to alight on the limited space available. This fact has been recognised, and these aircraft are flown and manned by members of the Naval air service who now are officers and men of the Royal Navy, not of the RAF. Thus the British Navy has its own force of aircraft which is integrally a part of itself and which is used in Naval operations. It is interesting to note, however, that with the progress of design these naval types of aircraft are tending to become variations of the standard land-based designs.

Land-based aircraft, however, take a great and ever increasing part in air operations over the sea. In our conditions they are highly important for the hunting and destruction of enemy submarines. We have therefore developed a large force of these aircraft organised in the Coastal Command of the RAF. An increasing number of torpedo carrying aircraft for use against enemy war and supply ships is also operating as part of this force. As these Coastal Command aircraft are either based on land, or are shore-based flying boats, they are manned and flown by members of the RAF. They are, however, under the "operational control" of the Admiralty. The Admiralty, that is to say, states its strategic plan and requirements to the commander-in-chief, Coastal Command (an RAF officer) who operates his aircraft accordingly.

Again there are certain types of aircraft which are specialised for work with the Army. These aircraft are also manned and flown by members of the RAF, but are organised in another command—the Army Co-operation Command.

The existence of these specialised sections of the RAF must not, however, lead anyone to suppose that the co-operation of the RAF with the Army and Navy is limited to the aircraft in Army Co-operation and Coastal Commands respectively, because all the fighter and bomber forces of the RAF are available and would be switched to operate in aid of either the Army or Navy or both, when the strategic plan of the higher command requires.

Our bomber force assists the Navy by attacking a special Naval target such as submarine building yard or warship in harbour; or by laying mines in enemy waters. Fighters assist the Navy when they attack a convoy of coasting steamers trying to make their way down the Channel. Or they may patrol over our coastal convoys. Bombers assist the Army when they destroy a factory like the Renault factory in Paris which was turning out tanks and motor vehicles in great quantities for the German Armies.

Air forces co-operate from their base at Malta when they sink a ship conveying tanks or other munitions to General Rommel's army in Libya. They were co-operating in this way for several months before the offensive by the land forces was opened last November.

Bombers and fighters co-operate also when the Navy or Army are themselves engaged in action with the enemy. Our bomber and fighter forces will be employed to the fullest possible extent in furthering Naval or military plans by attacking these targets the destruction of which will best assist the combined plan, and in gaining and maintaining air superiority to free our own aircraft to act in close support and to prevent interference with our service forces by the aircraft of the enemy.

Central control is, therefore, essential if the most effective help is to be given, the maximum concentration of air power is to be obtained and the maximum support afforded to the other services.

Operating in separate and distinct sections they would be more liable to defeat in detail by the enemy air force which is itself under central control.

These then are the reasons, as we see them, for the existence of the RAF in its present form. The Air Ministry, which is one of our major Government departments, analogous to the United States War or Navy Departments, is the headquarters of the RAF. At its head is a secretary of state, The Rt. Hon. Sir Archibald Sinclair, Bart., K.T., C.M.G., M.P. He presides over the Air Council consisting of 12 members, some of whom are civilians, some serving officers. This is, as it were, the cabinet of the Air Force, and runs the service as a whole. The senior service member of the Air Council holds the post of Chief of the Air Staff. This post today is occupied by Air Chief Marshal Sir Charles Portal, G.C.B., D.S.O., M.C. It is through him, a chief of the air staff, that the RAF is represented in the British higher command. For he is a member of the chief of staffs committee, which includes the chief of the Imperial general staff, representing the Army, and the First Sea Lord, representing the Royal Navy. This chief of staffs committee advises the prime minister and minister of defence, who is chairman of the defence committee of the cabinet.

I must now attempt, very briefly, to tell you something of the way in which the RAF is itself organised as a fighting force. It is divided into a series of commands. These commands are organised, partly on a functional, partly on a

(*Continued on page* 252)

AIR MINISTRY

by

SIR ARTHUR STREET, K.C.B., K.B.E., C.M.G., C.I.E., M.C., PERMANENT UNDER-SECRETARY OF STATE FOR AIR.

As governing body over RAF operations, the Air Ministry is responsible for the conduct of Britain's aerial war.

WHEN Armistice was declared in November, 1918, the clerks in the newly-formed Air Ministry flung open the windows of their offices and tossed bundles of documents hilariously into the streets below. Thus was heralded in the age of peace and plenty, which ended abruptly in 1931, when a Japanese army crossed the Chinese frontier into Manchuria.

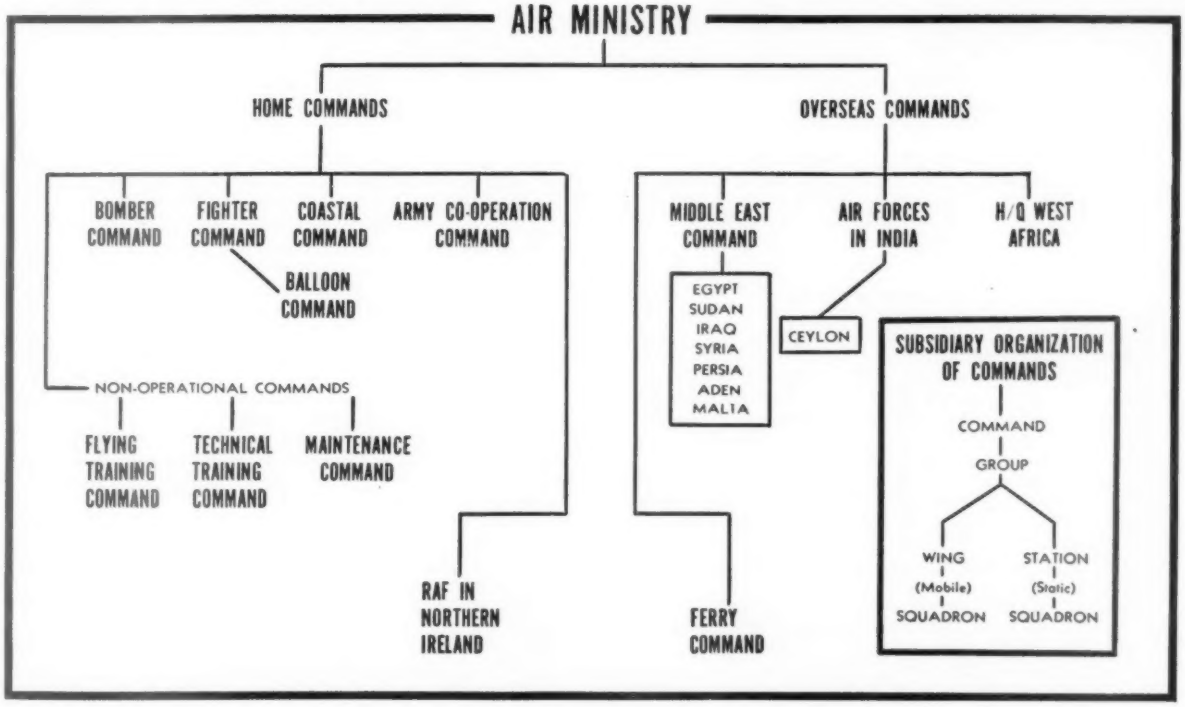
Meanwhile, the Royal Air Force, which, in 1918, was the largest in the world, had dwindled to insignificant proportions. The Air Ministry was correspondingly small. Slowly and reluctantly the British public came to realize that the years following "the war to end wars" were not the beginning of the millennium but the uneasy prelude to a world upheaval in which the peace-loving nations would be forced to take up arms in spite of their principles and in defence of them. So the RAF started to grow again and with it the Air Ministry —very slowly at first but with ever-increasing momentum as the warning notes grew louder.

In 1933, a sinister tyrant became master of Germany and a stream of refugees spread tales of brutal persecution and preparation for war. A year later, a modest dose of expansion was prescribed for the RAF. There were to be four new squadrons at once, followed by 11 more in 1935 and 1936. Events in Europe were soon to lead to successive enlargements.

The planning then was on sound lines and the outbreak of war found Britain with an Air Force which, though woefully small, was in quality more than a match for its adversaries. Schemes were drawn up by the Air Ministry in those pre-war days for the expansion of the aircraft industry. "Shadow" factories were projected to be kept on a care and maintenance basis until the emergency arose. Reserves of essential stocks and materials were laid down. Today, the Ministry of Aircraft Production—a war-time off-shoot of the Air Ministry—controls the operation of a vast production machine and it has had great success in overcoming the problems of large-scale production in wartime. But a share of the credit is due to those Air Force officers and civil servants who, in the years before the war, designed the machine and settled the shape it takes to-day.

As the tempo of events quickened, as the Italians showered the blessings of civilisation (in the form of high explosives and poison gas) on the defenceless Abyssinians, as Hitler re-militarised the Rhineland, invaded Austria, seized Czechoslovakia and attacked Poland, the Air Ministry made a prodigious effort to catch up with the growing and formidable air power of the Germans who had started to build up their forces at a time when we hoped, prayed and half-believed that to start a second world war was a form of lunacy to which no sane nation would succumb. Slowly we realised that other than sane people had to be reckoned with.

The sudden expansion of the RAF led to a corresponding



THE GOVERNING BODY OF

SIR ARCHIBALD SINCLAIR

The Rt. Hon. Sir Archibald Sinclair, Bt., K.T., C.M.G., M.P., Secretary of State for Air, President of the Air Council. He is 52, joined the Army in 1910, entered politics after the last war, has had a brilliant career in Parliament.

CAPT. HAROLD H. BALFOUR

Capt. the Rt. Hon. Harold Harrington Balfour, M.C., M.P., Parliamentary Under-Secretary of State for Air (House of Commons), Vice-President of the Air Council. He is 45, was in the R.F.C. in 1918, is still a flyer.

LORD SHERWOOD

Parliamentary Under-Secretary of State for Air (House of Lords), Lord Sherwood is 44. As Sq. Ldr. Sir Hugh Seely he commanded an RAF squadron which flew in France and the Battle of Britain. He entered politics in 1923, now is a baron.

SIR CHARLES F. A. PORTAL

Air Chief Marshal Sir Charles F. A. Portal, G.C.B., D.S.O. and Bar, M.C., Chief of the Air Staff, is 49, flew in the last war. Once during a flight he shot at the German ace Immelman with a rifle, hitting his plane.

AIR MARSHAL PHILIP BABINGTON

Air Marshal Philip Babington, C.B., M.C., A.F.C., is 48 and, during the last war served in the infantry before transferring to the R.F.C. He was awarded the M.C. for distinguished service in the field, has been in the RAF ever since.

SIR CHRISTOPHER COURTNEY

Air Chief Marshal Sir Christopher Lloyd Courtney, K.C.B., C.B.E., D.S.O., Air Member for Supply and Organisation, is 52 and has held commissions in all three fighting services. He has served extensively in India and Middle East.

expansion of the administrative machine in the Air Ministry. Once the Ministry was housed in one building. Now, in the third year of war, it is spread over 60 buildings and 10 towns. The telephone directory, giving the names of its officials, runs into 150 pages of close print. Inevitably, there was a great dilution of experience and a heavy burden was placed on those few experienced officials who carried through the transition from a peace to a war footing.

With the outbreak of war, staffs were evacuated from London to the provincial towns so as to be less vulnerable to air attack. This brought in its train a number of administrative problems. Officials had to be billeted in overcrowded towns, while there were difficulties in keeping contact between branches once working side by side and now separated by hundreds of miles.

At the same time a large number of the younger civil servants, whose experience was just beginning to be of value to the Ministry, were called up for service with the fighting forces. Meanwhile, expansion continued apace and there had to be large importations of inexperienced staff, many of them women. They rose nobly to the occasion. Somehow the peacetime standards of efficiency had to be maintained and even improved. A delayed decision might lose a battle; a wrong decision might lose the war. There was great need for secrecy and the army of temporary civil servants, who now form a large proportion of the junior staff, had to be taught to be security-conscious. A word carelessly spoken about the secrets of radiolocation or the performance of our fighters might have lost us the Battle of Britain. By the diligence and zeal of the Air Ministry's officials—RAF officers and civil servants alike—these difficulties have been overcome and though there will always be critics, the truth is that the Air Ministry in wartime functions as an efficient business organisation, larger in scope than the biggest commercial set-up—an oil company, a railroad or a steel corporation.

At the apex is the Air Minister, whose full title is Secretary of State for Air. Subject only to overhead decisions by the War Cabinet on major questions of policy, he has sole and undivided responsibility for the business of the Air Ministry and on him falls the burden of defending its actions in the House of Commons, of which he is a member. He is assisted in his arduous duties by two junior Ministers, the Parliamentary Under-Secretaries of State. One is a member of the House of Commons. The other is a member of the House of Lords and represents the Air Ministry in the upper house.

The Air Council is the governing body of the RAF, and orders from the Air Ministry to RAF formations are issued "By Command of the Air Council." The Secretary of State presides over the Council. The Parliamentary Under-Secretary of State (Commons) is its vice president. The Parliamentary Under-Secretary of State (Lords) is one of its members.

The Air Council also includes the executive heads of the chief departments into which the Air Ministry is divided:—(1) The chief of the air staff (planning, operations, tactics, intelligence), (2) the air member for personnel (personnel management, welfare and health of RAF and WAAF personnel at home and overseas), (3) the air member for supply and organisation (supply and servicing of equipment, logistics, transportation, civil engineering), (4) the air member for training (combat and flight training of aircrews and technical training of ground staff), (5) the permanent under-secretary of state (policy, exchequer, purchases, accounts, public relations and administration). All these, except the last who is a civil servant, are high-ranking officers of the RAF. The chief of the air staff, as an air chief marshal, has the same rank as the air officer commanding-in-chief of Fighter, Coastal and

THE ROYAL AIR FORCE

AIR MARSHAL A. G. R. GARROD

Air Marshal Alfred Guy Roland Garrod, C.B., O.B.E., M.C., D.F.C., is 51 and another officer who entered the R.F.C. during the last war. He has served in the Middle East and, in 1940, was appointed Air Member for Training.

SIR WILFRID FREEMAN

Air Chief Marshal Sir Wilfrid Rhodes Freeman, K.C.B., D.S.O., M.C., Vice-Chief of the Air Staff, is 52. In 1936 he was appointed to the Air Council as Air Member for Research and Development. He, too, was in the R.F.C. in 1918.

SIR HAROLD HOWITT

Sir Harold Gibson Howitt, D.S.O., M.C., F.C.A., is 56. At the outbreak of the present war he was appointed an additional Member of the Air Council to advise on financial matters. He is a veteran of the last war.

SIR HENRY TIZARD

Sir Henry Thomas Tizard, K.C.B., A.F.C., F.R.S., is 57 and served as a pilot in the last war. Assistant Controller of Air Research in 1918; 1927-29 Permanent Secretary of the Department of Scientific and Industrial Research.

other operational Commands of the RAF, but he is in effect No. 1 man of the RAF. Civilian experts in administration work in the departments of the "air members"; and RAF officers work alongside civilians in the department of the permanent under-secretary of state. This integration of RAF officers and civil servants working in close harmony and understanding each other's qualities and limitations is a valuable feature of the organisation.

There are four other members of the Air Council who are not heads of any Air Ministry departments. One is the vice chief of the air staff. One advises the Air Council on financial and kindred questions. The other two belong to the Ministry of Aircraft Production.

The Air Council may be likened to the board of directors of an industrial undertaking. Its main job is to keep the RAF in the air, well-trained, well-equipped, fighting fit and punching the enemy all the time where it hurts most. Its chief functions are therefore administrative and executive but it also acts in a judical capacity. Thus, it reviews the sentences of courts martial which it can reduce but not increase; and it is the High Court of Appeal to which persons subject to the RAF code of discipline can apply for redress of grievances, real or imagined.

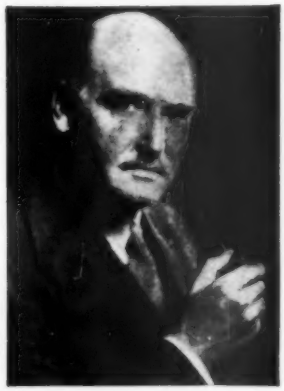
The organisation of the Air Ministry does not end with the departments controlled by the Air Council. The civil aviation department, which in wartime directs the resources of British civil aviation at home and overseas in the interests of the war effort, comes under the secretary of state for air, although it is administratively controlled by the permanent under-secretary of state.

The meteorological office, which performs the all-important service of giving the RAF the weather reports without which no operation could be successfully planned, is in itself a vast organisation with stations scattered throughout the world. It serves the Army and the general public as well as the RAF. Like the department of civil aviation, it is responsible to the secretary of state for air and is controlled administratively on his behalf by the permanent under-secretary of state.

So much for the "high-up" organisation of the Air Ministry. What of the men and women who spend their days (and often their nights as well) serving the great machine? In a bomb-proof basement officers of the WAAF are decoding secret messages, telegraphed or radioed from all parts of the world; elsewhere, Air Force officers are engaged in perfecting arrangements for co-operating with the Royal Navy in the protection of convoys; others are calculating the number of spare parts

AIR MARSHAL F. J. LINNELL

Air Marshal Francis John Linnell, C.B., O.B.E., is 50 and Controller of Research and Development in the Ministry of Aircraft Production. Appreciation from the Air Council says he has "contributed largely to efficiency of RAF wireless."



SIR ARTHUR STREET

Sir Arthur Street, K.C.B., K.B.E., C.M.G., C.I.E., M.C., Permanent Under-Secretary of State for Air, had a distinguished career in Civil Service before being appointed to his present post. He was in an infantry regiment in the last war.

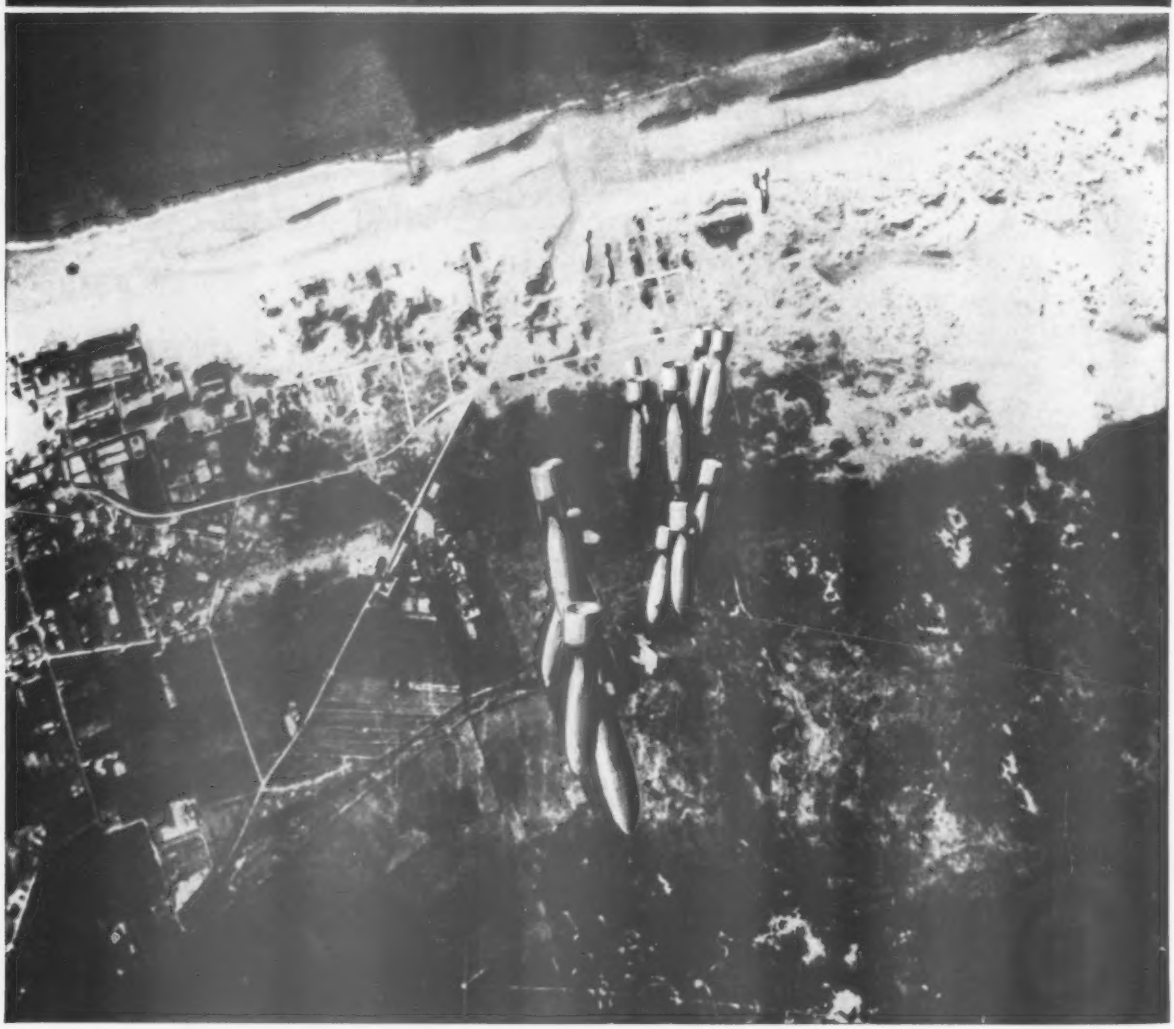
to be sent with a consignment of aircraft to the Russian front; in another room you may find a civil engineer poring over the plans for a projected oil storage; elsewhere, a civil servant will be negotiating the price of a large supply of material and a big deal will be put through. There is almost no limit to the diversity of jobs which are being done in the Air Ministry and people of all walks of life jostle each other in its corridors: cabinet ministers, stenographers, journalists, air marshals, engineers, administrators, aviators and technicians.

They are all actuated by a spirit of vital urgency. They know that they must put every ounce of effort into their job to hasten the day of victory. But they are also imbued with a sense of humility; for where their labours end the work of the RAF begins, and they know that however much they toil they would achieve nothing were it not for the skill and valour of the officers and men of the RAF engaged in writing victory in the skies. One and all, they are inspired and sustained by the knowledge that they are of service to the brave youth who fly and fight and die that freedom may live.

END

BOMBER COMMAND

Methodically smashing German industry to bits, the Bomber Command leads the RAF offensive.



The Operations Room at Bomber Command Headquarters. At desk in foreground is Air Chief Marshal Sir Richard Peirse, former Air Officer Commanding-in-Chief, Bomber Command. Maps show bombing objectives.

by

Arthur T Harris

AIR MARSHAL SIR ARTHUR T. HARRIS, K.C.B., O.B.E., A.F.C., COMMANDER-IN-CHIEF BOMBER COMMAND, was born in Cheltenham, Gloucestershire, in 1892. Prior to the outbreak of World War I he had been a tobacco planter in Rhodesia, and, in October, 1914, joined the 1st Rhodesia Regiment and transferred to the Royal Flying Corps in November, 1915. He was in command of the first night flying experimental detachment for the defence of London against Zeppelins. He commanded the RAF in Palestine and Transjordan. He was appointed to his present post in February, 1942.

THE best way to understand the organisation of Bomber Command is to follow the course of a typical operation from the moment when it is decided upon. Tonight, let us say, 250 bombers are to attack the port installations and the Heinkel aircraft factory at Rostock. In addition, there will probably be an attack by less experienced crews on an objective nearer home, and a number of aircraft will be laying mines in enemy waters. We, however, will trace only the progress of the attack on Rostock. We will watch the orders go from Command to Groups and from Groups to Stations, and see reports of the attack return along the same channels.

The general policy of bombing, which includes the Baltic ports as objectives, is decided at the Air Ministry. At Command the decision is made to attack Rostock itself, in preference to some similar objective, on this particular night after considering various strategical and tactical factors and also the weather forecast.

The figure of 250 bombers to be despatched is decided after considering the type and importance of the target, the degree of urgency of the attack, the effect required and the number of aircraft and crews available. The period of moon and probable state of the weather, not only over the target but en route and also over the home bases at the time of take-off and landing, must also be taken into account.

It may be decided to get the attack over within an hour in order to have a heavy concentration of bombers over the target at any one moment, so that the defences may be saturated, the guns and searchlights being unable to converge on a single bomber at one time. Or it may be decided to attack a target with bombers coming in at intervals throughout the night. If the weather is uncertain, or other difficulties are expected, an alternative target may be chosen. The crews attack the alternatives only if they cannot make the primary target. The type of load the bombers are to carry is considered, from incendiaries to the heaviest high explosive bombs. The type of bomber most suitable for each stage of the attack is also decided.

Our attack on Rostock is a night attack, and the plan is worked out early on the preceding morning. When the plan is made, orders go without delay to the Bomber Groups. Each Group commander decides what squadrons are to operate and works out the exact bomb loads, the time to reach the target, and other tactical data, in more detail than is done at Command. The more detailed orders are then sent on to the Stations concerned.

At the Station all the particulars about the target are looked up in secret reference files. Here is found a detailed account of the nature of the target. Large scale maps and photographs show the Heinkel works, the railway stations, the docks, the town and other details, such as the most prominent landmarks. With the maps is a concise explanation of the importance of the target.

The operations and intelligence officers set out all the available data in the most suitable form, and place it at the disposal of the officer who is to conduct the "briefing"—that is, the instruction of the bomber crews on their night's work. The briefing is done either by the Station commander or the commanding officer of one of the Squadrons operating. The latter is a wing commander, and is probably going on the raid himself.

The crews detailed for the night's operation assemble for briefing at, say 3:30 p.m. At that time a hundred or so young men are seated in a big room. Covering the wall in front of them is an immense map of northwest Europe on which is stretched a tape showing the route to the target. On the other walls are other maps showing details of enemy defences and photographs of the target.

The briefing officer begins with a few words about the importance of the target. He tells the crews the latest estimate of the proportion of German aircraft production for which the

Shortly after their arrival in England these pilots of a New Zealand Bomber Squadron of the RAF distinguished themselves in action against the enemy. Their squadron leader received the D.F.C.

Heinkel works is responsible. He explains that the neighbouring town of Rostock itself contains many objectives of military importance, such as docks, U-boat building yards, and subsidiary Heinkel factories. The curtains of the room are drawn and the plan of the target is shown on the wall by the epidiascope.

This squadron, perhaps, has been ordered to make special low level attacks on the Heinkel works, while other Squadrons are bombing elsewhere. The officer who is briefing warns the pilots not to be distracted by smoke and flames, which they will certainly see arising from other objectives or from decoy fires, but to use these merely as landmarks by which to pin-point their position so that they may be sure of finding the big assembly sheds of the aircraft factory. He then explains the route out and back.

His whole talk has not taken more than 10 minutes. He is followed by the station meteorological officer, who forecasts the weather likely to be encountered during the flight. Navigation, signals and armament officers give their advice and instructions. All queries, however detailed, are answered. As a postscript, the station commander offers his advice and encouragement, and perhaps reminds the crews that they are also carrying leaflets and must ensure that their early morning "news delivery" reaches the proper areas en route.

What of the crews, their thoughts, their feelings? Some sit studiously, note-taking. Some show ill-concealed impatience for action rather than words. Most are imperturbable, sitting back, drawing periodically at a pipe or cigarette. All have spent the previous hours inspecting and testing the equipment of their aircraft, culminating in a final test flight to check everything to the last detail.

The briefing over, the silence of the room is broken by a hubbub of voices as the crews discuss the job in hand among themselves. Then they leave to set about their particular tasks. No one who has attended the briefing must leave the station; they are in possession of information which would be invaluable should any hint of it reach the enemy during the next few hours. But the crews still have a lot to do before the time of take-off. Each must plan exactly what is to be done in every circumstance. Navigators work out courses, the effects of the forecast winds at different heights and the stars most likely to aid them, or discuss with the pilot probable fuel consumption at different air speeds, and all the other complicated problems of their craft. Wireless operators check their lists, ground station frequencies and their call-signs. All require, and get, a hearty meal.

The time comes to get going. There is a move to the crew rooms to put on flying clothing. The dressing up, the checking of parachutes and "Mae Wests"—these the life-saving inflatable waistcoats which the crews wear in case their aircraft has to come down in the sea—takes some time. Tenders call to take the crews out to their aircraft a good 45 minutes before the actual time of take-off. It may be a mile across the aerodrome to the aircraft. When they reach it there are still a good many things to do.

The captain of the flying crew speaks to the men of his maintenance crew who are gathered round the aircraft. He questions them to see that any minor adjustments which he has

H.M. King George is a frequent visitor to RAF stations. Here he listens as bomber crews receive final instructions before setting off on a raid.

Nearness of chief RAF bombing objectives is vividly portrayed on this scale map. Naples, Italy, farthest point is about 1,100 miles from London. Thousand-plane raids are directed against these centres.

asked for since the last flight have been duly made. The gunners climb into their turrets and check over the complicated mechanism of their guns. The navigator gets out his charts and clamps them down on the chart table, like a draughtsman settling down to a quiet day's work in his office.

When all this final checking and settling down of the crew is over there may be no more than 15 minutes to go to the time of take-off. It is time to start up.

The starting of a four-engined bomber is an impressive business. The aircraft looms black and ominous in the night. In the glimmer of dimly shaded lights, orders are passed and repeated in a queer cryptic jargon—"port outer ready" . . . "starboard inner ready" . . . "contact." The engines grumble into life. The grumble becomes a growl, the growl a roar. From out of the darkness the roar is echoed and re-echoed as other aircraft come to life at distant dispersal points.

The ground crews stand clear as the pilot tests his engines. He waves to them to pull away the chocks from the wheels. He holds the aircraft on its brakes with the engines idling; a soft hiss as the brakes release, and 30 tons of bombs and bomber roll smoothly forward into the darkness.

The pilot turns her head into wind. Facing him is a mile and more of concrete runway. All he can see of it is a line of closely shaded lights along its edge, a dimly lit street disappearing into murky perspective. Exactly on time the signal lights at this end of the flare-path change to green. The pilot opens out all four engines. The aircraft begins to roll down the runway. The weight shift from tail to wheels, from wheels to wings as the pilot gently eases back his control column. Before the runway ends they are airborne, before the boundary lights they are gone.

Queuing up behind are eight or 10 other bombers. The instant the first has left the second takes its place. Ten may be off in as many minutes. Each circles once before setting course for the objective—five or six hundred miles away, in the heart of Europe.

For those who remain on the Station there may be five hours or more of waiting. In the small hours of the morning the Station commander and other senior officers assemble in the control tower. For them the most anxious moment of the operation is at hand. The first thing that they hear may be the drone of returning engines—or it may be a voice easily

AIRCRAFT OPERATED BY BOMBER COMMAND

The Douglas "Boston" has been effectively used by the RAF as the spearhead of its daylight attacks in Northern France.

Handley Page "Halifax" carries nearly six tons of bombs. Its four Rolls Royce "Merlin" engines provide 4,700 h.p.

The Short "Stirling" can carry a load of eight tons of bombs at a speed of nearly 300 m.p.h. at 14,000 feet altitude. Four 1,600 Bristol "Hercules" engines provide power for 87-foot long craft.

recognisable as that of one of the pilots, speaking on the wireless telephone to the control room.

There is a crackle from the loud speaker as it clears its throat; a voice tells them that "'P' for Peter" or "'T' for Tommy," or whoever is talking, is approaching the aerodrome at, say, 5,000 feet. Communication established, instructions for landing and permission to land are telephoned to him. Usually WAAF telephone operators carry out this responsible task. Women's voices, being usually clear, are particularly suitable for wireless telephony.

This first aircraft looms out of the night. All the pilot sees is the shaded narrow gleam of the flare path. The watchers in the control tower see him land and taxi off to his dispersal point. Two or three more of the squadron are by then probably in radio contact. They are instructed to circle the aerodrome at various heights. One by one they are brought in to land. The Station commander checks them off his list as they come in. Will there be one or two missing, or will they all come back? That is the silent query occupying every mind. On the four highly successful Rostock raids our losses were, in fact, extremely small. Many squadrons had no casualties at all. On other nights they are not so lucky.

Next door to the briefing room in the headquarters block is the interrogation room. There the returning crews assemble. The first thing they do is to take a cup of hot tea or cocoa from the orderlies. Then they begin to tell the intelligence officers about the raid. Almost before they have spoken you know whether it has been a success; the crews show it at once in their faces, in their whole demeanour. They have seen the lurid sight of flaming factories. They know they struck home.

They have to give a detailed report. The captain fills in a questionnaire, in which he says exactly what he saw where his bombs fell, what the defences were like, the intensity of anti-aircraft fire, whether he was caught in searchlights. When he has finished, he and his crew go and sit down round a desk over which an intelligence officer is presiding. Here they go through the form together amplifying and clarifying. They talk over every incident of the trip. The intelligence officer records everything they saw and did.

This interrogation provides the material for the initial reports on the night's attack. Everything of consequence is summarized and teleprinted to Group Headquarters and Bomber Command. The reports of the crews give a very good idea of the degree of success of the attack. Often they contain the only evidence that can be gained about the enemy's defences, the tactics of German night fighters and the like. But at Group Headquarters and Bomber Command the evidence of the crews is only taken as a preliminary report on the damage done to the target.

More and more, as the offensive against Germany has developed, the importance of photographic evidence has in-

(*Additional photographs, page* 55; *text page* 56)

By the THOUSANDS!

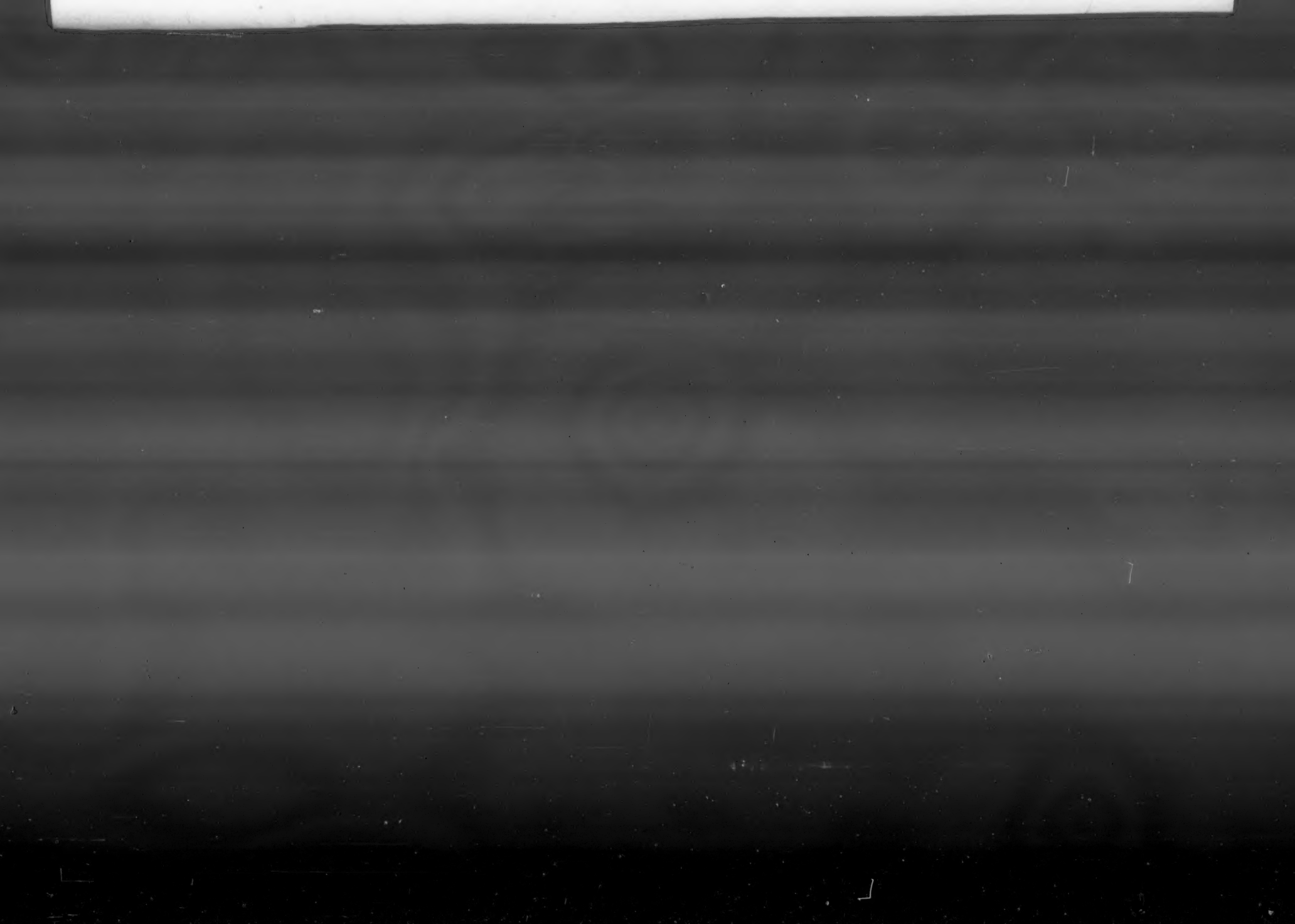
Combat ability alone has won fame for the Curtiss P-40's in today's world-wide conflict. . . . Still, the shining fact in the record is that so many *thousands* of them were produced at a time when striking power was so desperately needed. Today production continues unabated.

CURTISS-WRIGHT
Corporation
AIRPLANE DIVISION

Curtiss P-40's are on every battlefront. Tomahawks and Kittyhawks are in use by the British. The new Warhawk is supplementing earlier models now in service with the U. S. Army Air Force.

INVADERS

Last-minute instructions are given the crew of a "Stirling" before their take-off for a raid on Germany.

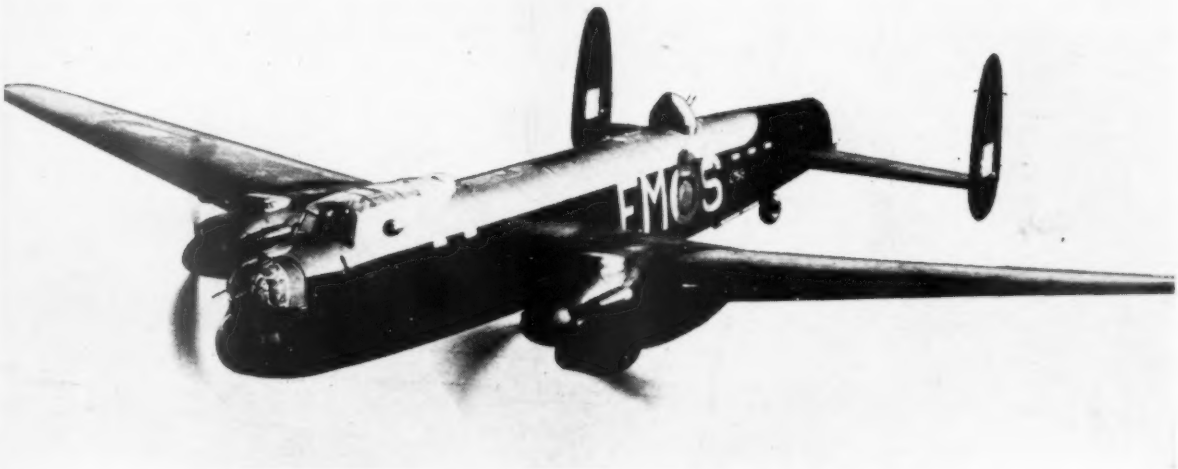


AIRCRAFT OPERATED BY BOMBER COMMAND

(*Continued from page 50*)

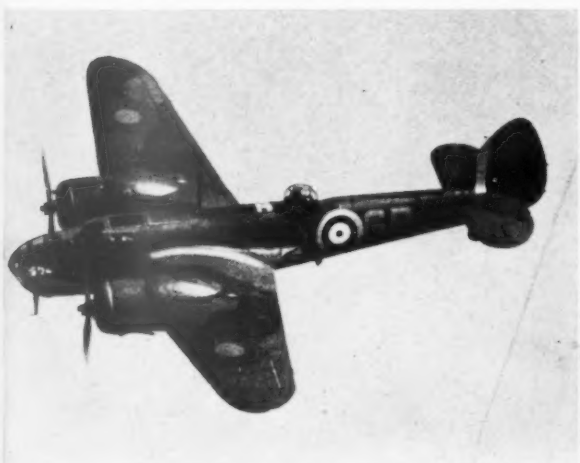
With a maximum speed of 245 m.p.h., the Armstrong Whitworth "Whitley" bore the brunt of RAF's early operations.

Handley Page "Hampdens," with top speed of 265 m.p.h., have been blasting the enemy since the outbreak of war.



The Avro "Manchester" was for a time the fastest twin-engined bomber flying in the RAF. It now is being superseded by the Avro "Lancaster." Performance data on this new aircraft are restricted.

The Bristol "Blenheim" is used with equal success in bomber or fighter operations. Its maximum speed is 285 m.p.h.



The Vickers-Armstrong "Wellington" is another veteran of the opening phases of the war. It carries 4,500-pound bomb load.

Bomber Command's new four-engined "Lancaster." The existence of this 30-ton aircraft was not disclosed until it had participated in the daring daylight raid on the Diesel works at Augsburg.

creased. As many night photographs as possible are taken during the attack. These provide positive evidence that the aircraft has been over an area which includes the target. Night photographs also show the size of fires and sometimes the bursting of bombs, but they cannot show the precise extent of the damage. For this it is necessary to wait until a reconnaissance aircraft has flown over the target in daytime and photographed it. Then, and only then, is Bomber Command satisfied that the work has been completed.

So much for one of countless operations. Organisation, aircraft and men are prepared for operations whenever conditions are suitable, for as long as the war may last. Night and day as conditions allow, from Norway to Italy, from the Atlantic to the borders of Poland, Bomber Command aircraft range on their missions. Farther, faster with ever-increasing loads, in ever-increasing numbers. It is for the enemy to cry "Enough."

The first British bombs fell on the soil of the German mainland on the night of May 11, 1940, when a force of 18 *Whitley* bombers attacked railroad communications behind the lines of the German advance across Flanders and the Low Countries. Light bombers of the Command, at that time *Blenheims*, also endeavoured to stem the onrush of the attack by desperate and costly sorties against immediately threatening enemy concentrations.

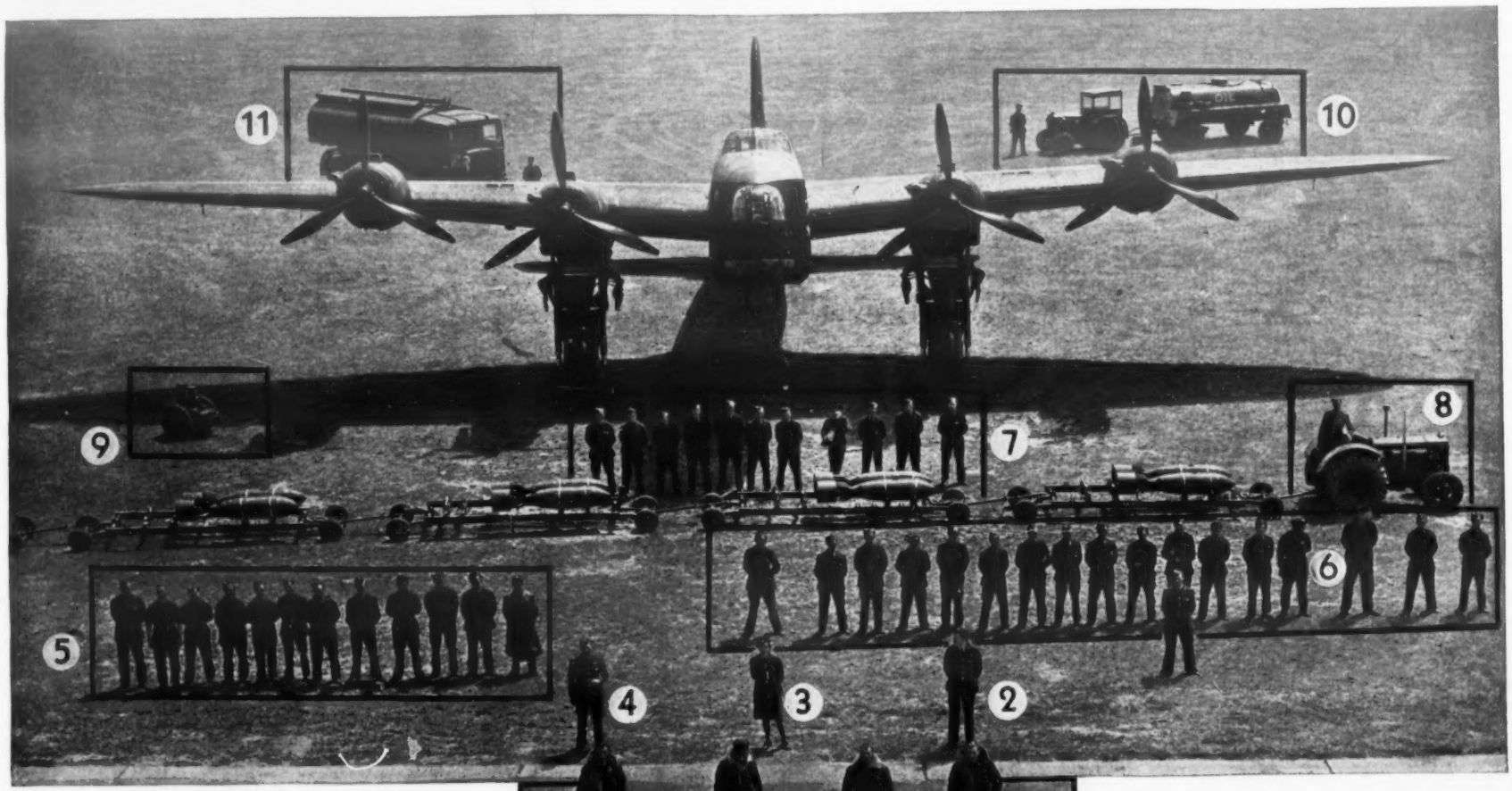
After the fall of France, Bomber Command had a defensive role to play. This country, from which alone air attacks against Germany could be launched, was itself faced with the threat of invasion.

This defensive phase was at its height in the late summer and autumn of 1940. The German High Command had collected some 3,000 barges in the "invasion ports" in the Channel and the Low Countries. They intended to use these craft to bring an invading army, flushed with victory, to British soil. Our bombers did immense destruction in all the ports from which the Germans had planned to sail. Hundreds of the invasion barges were wrecked, and large quantities of equipment and stores at the docks were destroyed. Today only a very small part of Bomber Command's effort is directed against these harbours—just enough to keep them sweet.

Long range bombing attacks were also made against a number of industrial targets in Italy. Thus, Mussolini, who had envisaged easy money from an easy war, and whose role of jackal had set him to licking his chops under the Nazi table, received nothing more palatable than a meal of high explosive and incendiary bombs. The material damage was light; it may have been repaired long ago; but Italian morale has never since recovered.

There has always been the closest co-operation between the Navy and Bomber Command. Target after target of naval importance has been heavily attacked. The great dockyards at

Armourers store the "eggs" aboard a Short "Stirling" for transport across the North Sea. The big four-engined craft has a wing span of 99 feet and its loaded weight is 70,000 lbs. Its crew numbers seven.

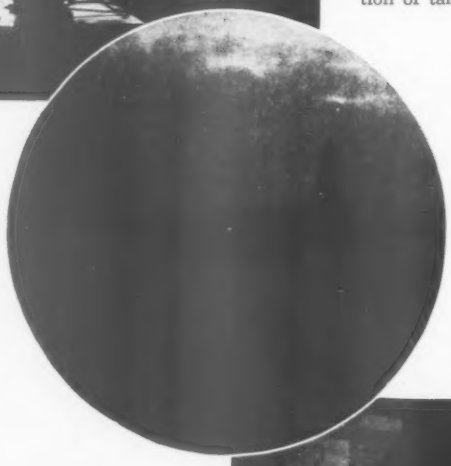


TEAM

THIS Short "Stirling" bomber, with its four Bristol "Hercules" engines giving it 6,400 h.p., its wing span of 99 feet, length of 87 ft. 3 in., height of 22 ft. 9 in., gross wing area of 1,460 sq. ft., and a weight, loaded, of 70,000 pounds, has a maximum speed of nearly 300 m.p.h. at 14,000 feet. It can carry a bomb load of eight tons. It is manned by a crew of seven, carries two guns amidships in upper turret, four guns in tail turret. To operate this colossus, a total of 56 personnel is necessary.

1. The air crew: captain, 2nd pilot, flight engineer, observer (navigator), wireless operator, air gunner-bomb aimer and two air gunners.
2. Meteorological officer.
3. WAAF parachute packer.
4. Flying control officer.
5. Flight maintenance, numbering 12.
6. Ground servicing, numbering 18.
7. Bombing-up team, numbering 11.
8. Bomber tractor crew.
9. The starter battery is operated by No. 5 group.
10. Oil bowser driver.
11. Petrol bowser driver (a corporal) with one A.C. 2.

Bombers heading for the night's target are checked by Flying Control Officer.



A Vickers-Armstrong "Wellington" bomber silhouetted as it heads for Germany.

Kiel, Hamburg, Bremen, Wilhelmshaven and Brest have been frequently, heavily and successfully raided. Our light bombers, now reinforced by American *Bostons*, have constantly attacked enemy shipping. U-boat bases along the whole coast of western Europe from the Baltic to Lorient and Bordeaux have regularly received the attention of Bomber Command. Bomber Command has done most of the mine-laying along the same long coast-line. History will show enemy shipping losses in our air-laid minefields as a major contribution to the outcome of the war.

Throughout this time the bomber force has been gradually increased, not only by the addition of more aircraft and aerodromes, but also by the replacement of existing types by the four-engined heavy bomber, capable of carrying three times the load of the medium and 10 times the load of the light bomber. The rate of expansion has been determined not only by the rate of production and the supply of raw materials from across the Atlantic, but also by Britain's manifold commitments in the other world-wide theatres of war. There have had to be many diversions. Nevertheless, there is now at our disposal a powerful offensively-equipped and offensively-minded force with a well-earned reputation for causing damage to the Nazis' war machine and dismay to the German High Command.

Bad weather may hold up the offensive. But nevertheless Bomber Command all the time pins down at least 1,500,000 Germans in active or passive defence against bombing and sea mining, including 700,000 fully trained troops handling searchlights and antiaircraft guns. A typical spell of bad weather occurred this last winter, but with the spring the offensive was resumed.

On the night of March 3, the great Renault works near Paris were attacked. It was impossible to allow the Germans to use unchallenged the great industrial plants of France for the production of tanks, aeroengines, lorries and other military equipment. That night, in the short space of two hours, a force of bombers destroyed the largest of these French plants. This one raid robbed the Germans of all the armoured fighting vehicles and transport of five motorised divisions for a long period.

Our offensive was then switched to the Ruhr—the most highly industrialised region of Germany. In April, 12 of our heaviest four-engined bombers—*Lancasters*—made a daylight attack on the great M.A.N.

Ground staff officers gather to "count in" planes returning from bomber raid.

Upon their return from bombing missions, flight crews give comprehensive report of operation to Intelligence Officer.

The proof of the bombing is in the seeing. Here a composite of reconnaissance photographs shows damage done by RAF when it rained thousands of bombs on Baltic port of Rostock.

Works at Augsburg in central Germany where submarine engines are produced. Although our bombers suffered heavy losses they destroyed the main assembly sheds of the works, proving that, although as yet at a high cost, it is possible for us to pick out key industrial points in Germany and destroy them by means of daylight raids. At the end of the month Rostock and Lubeck, two Baltic ports of importance, were devastated in the most successful night attacks which had taken place up to that time. The greater part of May was marked by the reappearance of weather unsuitable for bombing, but on the last night of the month fine weather returned.

We seized the opportunity by mounting the greatest air raid of the war. Considerably more than 1,000 bombers were sent over the great Rhineland city of Cologne to deliver their loads of incendiaries and high explosives within the space of 90 minutes. Two nights later over 1,000 aircraft were despatched to the key industrial area of the Ruhr.

These were more than air raids; they were world events. As it has become impossible to hide the damage which was inflicted—in the Cologne raid in particular, the whole world has come to realise the vulnerability of Germany to air attack. We have obtained conclusive photographic evidence from our reconnaissance machines which tells us the extent of the damage. You will have seen accounts of it in the newspapers. It is particularly gratifying to us to see

Cologne, target of RAF's first thousand-plane bombing raid May 30, 1942. Light patches show large areas blasted by high explosive bombs. Great havoc was also caused by incendiaries.

that the largest areas of devastation include the most important industrial plants in the whole city of Cologne. It might be thought that the world wide repercussions of these great raids were out of proportion to the amount of actual material damage done; for although that damage is very serious, yet it is perfectly true that it is not enough in itself decisively to impair the war-making ability of Germany. But with an instinct which, as so often is correct, the people have grasped not merely what has been done, but what can be done.

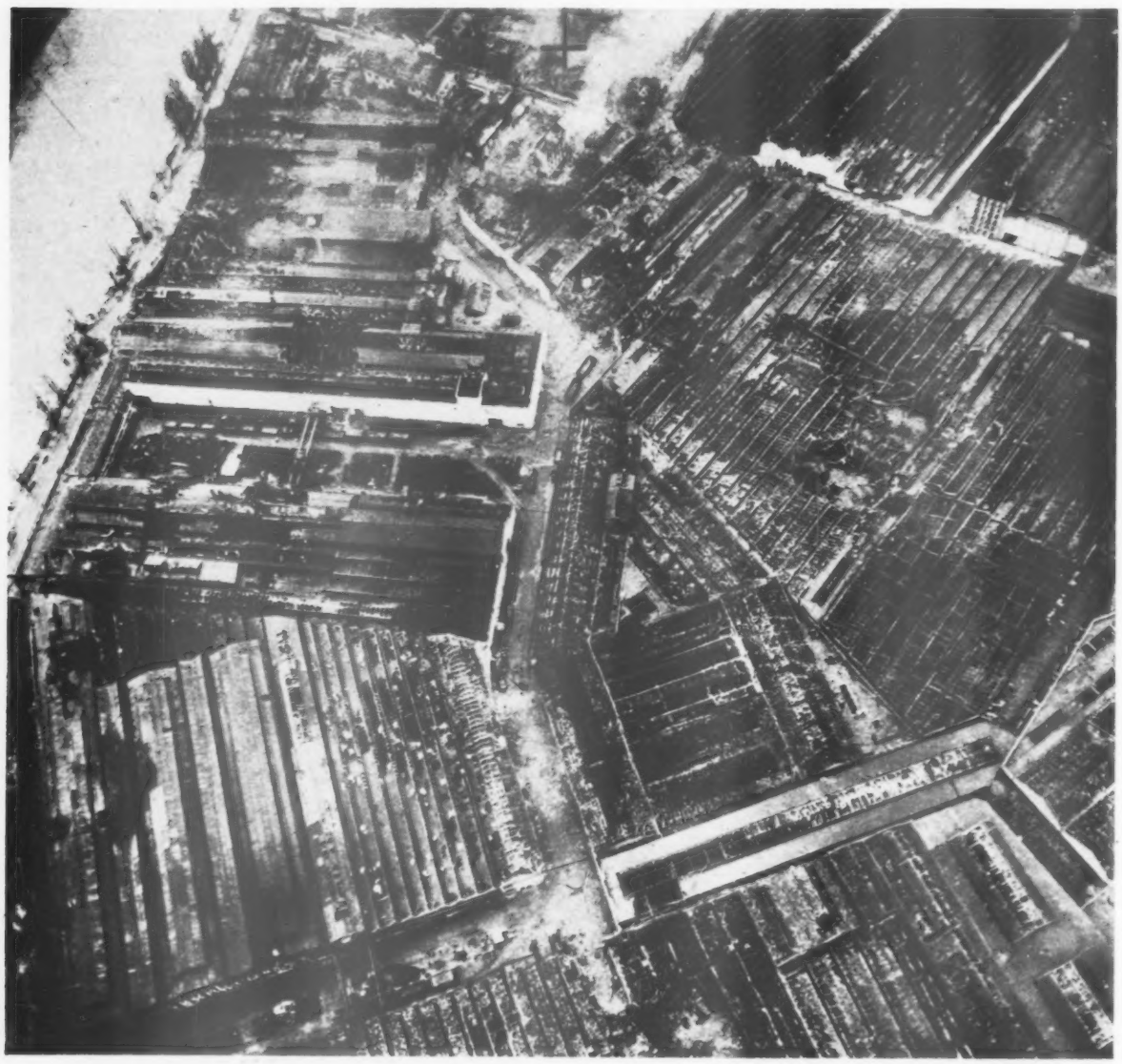
It must not be thought that we can immediately mount raids on this scale every night or even every week. On the other hand, we have already given proof that the occasional undertaking of a raid of this sort does not impair our capacity to continue our steady but ever increasing and ever more deadly raiding of Germany on a smaller but still very heavy scale. The raids on the ports of Bremen and Emden were, for example, particularly successful. Very heavy damage to the shipbuilding and submarine-building yards at Emden was effected.

Germany lies open to our attack. Already, by means of the efforts of the RAF alone, raids of 1,000 bombers can be undertaken. As everyone knows, we are about to welcome bombardment squadrons of the United States Army Air Forces.

Henceforward the attack will be intensified. Germany faces an air attack which will make the bombing of Britain in the winter of 1940-41 insignificant. The weight of attack, the damage and the destruction will ascend in a devastating crescendo. We can never have too many heavy bombers. British production of them is becoming very large. The United States Army Air Forces will soon base an ever increasing number of its heavy bombardment squadrons on British airfields. You cannot send too many. Every ton of bombs which U. S. heavy bombers drop upon Germany will shorten the war and will save the lives of thousands of American and British soldiers in the final conquest of Germany. We will bomb Germany so persistently and so severely that her powers to make war will be crippled. We will bomb her for all the world—especially Italy and Japan—to see and to ponder. The way is clear. The proofs—Lubeck—Rostock—Heinkels—Renaults—Cologne—Essen—Bremen—Emden, and a dozen others—are there. Germany's air power is declining. That of Italy had declined earlier for her heart is not in this war. The United Nations have only begun their climb to production. No Power, no combination of Powers, can hope to stand against that rising tide.

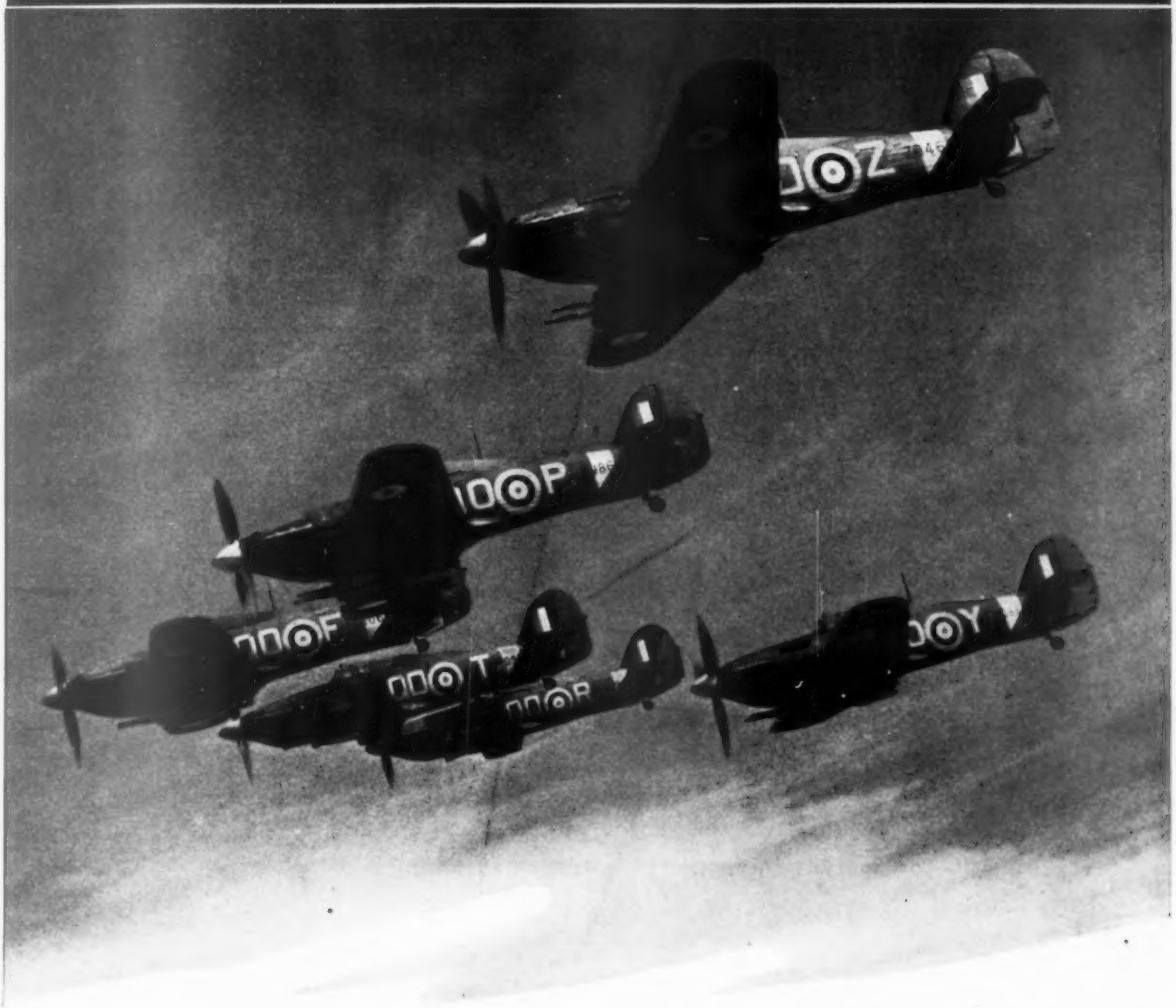
END

Accuracy of RAF's bomb aimers in hitting military objectives "on the head" is vividly revealed in this reconnaissance photograph of havoc after Bomber Command visited the Renault Works, Paris.



FIGHTER COMMAND

England owes its very existence today to these grim, young fighting pilots who outfought destiny with a handful of airplanes.



Four-cannon Hawker "Hurricanes."

FIGHTER COMMAND

by

Sholto Douglas.

AIR CHIEF MARSHAL SIR SHOLTO DOUGLAS, K.C.B., M.C., D.F.C., has been Air Officer Commanding-in-Chief, Fighter Command, since November, 1940. Born in 1893, he was educated at Tonbridge School and Lincoln College, Oxford, then joined the Army in 1914 as 2nd Lieutenant Royal Field Artillery. In 1915 he joined the R.F.C., attaining the rank of lieutenant colonel. Was awarded M.C., D.F.C., and Croix de guerre. One of his squadrons, No. 84, shot down 201 German planes. He has been an expert on air fighting ever since; his RAF Staff College lecture on the subject has become a standard work. He was Assistant Chief of the Air Staff, 1938-40, then Deputy Chief of the Air Staff in 1940.

FIGHTER Command of the Royal Air Force is animated by a single policy—to attack the enemy wherever he can be found within fighter reach.

This offensive policy has been pursued with ever-increasing strength since the end of the Battle of Britain, when the Command met its responsibility for the protection of Great Britain against air attack by the decisive defeat of a numerically superior force. Today Fighter Command carries the war to the enemy in a constant series of day and night attacks which are in themselves the best form of defence and the precursor of that complete air supremacy which is essential to final victory.

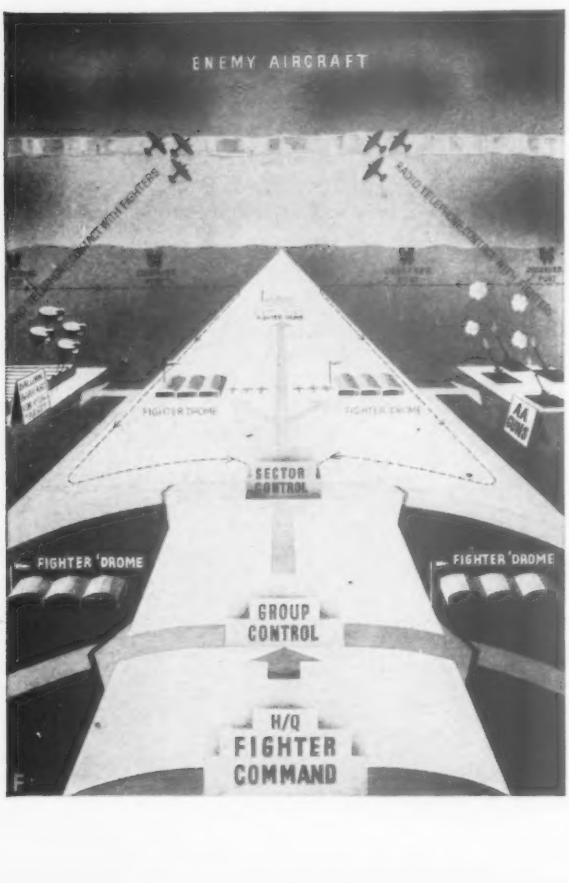
Under the control of Fighter Command are all fighter squadrons in the United Kingdom and, as they are integral parts of the air defence organisation, such allied services as the antiaircraft guns and searchlight batteries, the Royal Observer Corps, and the balloon barrage are also subject to the operational control of Fighter Command. Upon Fighter Command rests also the responsibility for initiating civil air raid warnings throughout the country.

The fighter squadrons are based on airfields, allocated exclusively to fighters and distributed over the length and breadth of the country. Two, three or more fighter squadrons may share a common airfield and day and night fighting units may operate independently from the same base.

In daylight, fighter squadrons detailed for defence duties do not normally maintain patrol lines on the off chance of meeting the enemy. The range of modern fighters is too limited to make such a system either practicable or tactically sound, so for daylight defensive purposes the fighter squadrons do not leave the ground until it is known that there are enemy aircraft to be intercepted and attacked.

In place of the daylight standing patrol it is the practice of Fighter Command to have on all its airfields at least one fighter squadron instantly ready for action. Such squadrons are known to be "at readiness," and until relieved by another squadron their pilots wait close at their dispersed airplanes, ready to leave the ground within a few minutes of receiving the order. Other pilots and airplanes on the airfield are also kept available at short notice while, if the need arises, the full fighter strength of the base can quickly be put into the air.

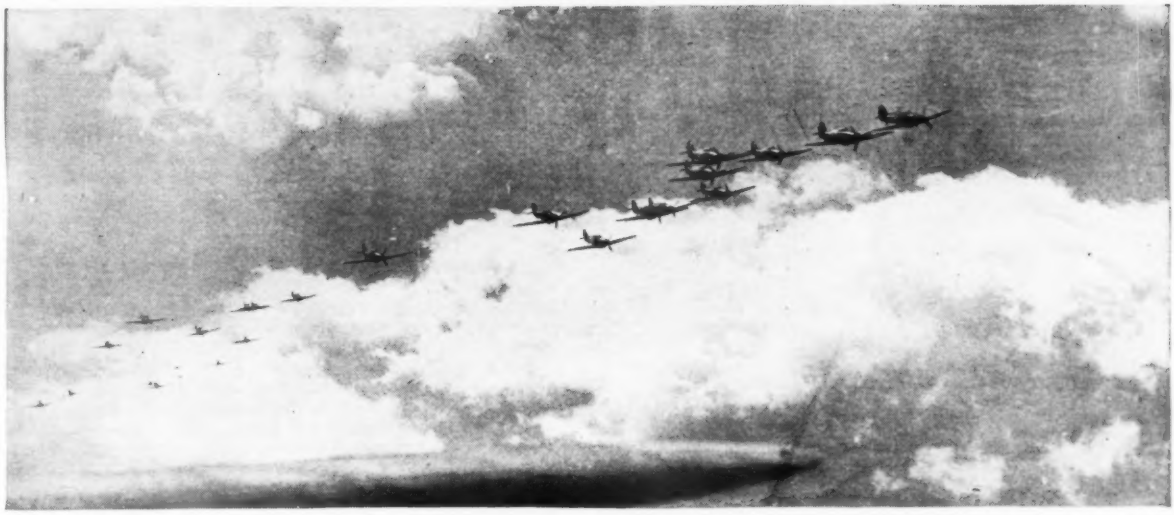
Nerve-centre of a Fighter Command station is its operations room (above). Air and ground defence activities are co-ordinated here, making for the closest possible co-operation between fighter planes, antiaircraft guns, barrage balloons and observer posts. How this chain of command works is shown at the left.



For the purpose of efficient operational control, fighter airfields are grouped into "sectors," each sector comprising several airfields and having a central control or operations room. It is from these sector operations rooms that the sector controller, in direct communication by radio-telephony with the pilot in the air, controls the movements of the fighters in his area.

Sectors in their turn are controlled by a Group Headquarters. Six or seven sectors, comprising a total of some 18 to 21 fighter bases and perhaps twice that number of fighter squadrons, may be included in a group.

These Fighter Groups cover the whole of Great Britain and Northern Ireland and they are all co-ordinated and controlled by Command Headquarters. A network of communications—telephone, radio and teleprinter—connects each fighter station to its sector and each sector to its Group Headquarters, the



Trouble on the way. Hawker "Hurricanes" and "Spitfires," climbing through the clouds to intercept a force of enemy bombers reported heading for an objective in Great Britain.

final link leading to the nerve centre of the whole system—Fighter Command Headquarters.

Within this framework the organisation of the Command is kept as flexible as possible. All fighter squadrons are highly mobile and can be re-grouped over-night from sector to sector or Group to Group to meet changes in the strategic situation. Before the war, Fighter Command was organised only to look eastwards. The possibility of air attacks on Great Britain from French and Norwegian bases had not been envisaged or allowed for. There were no fighter bases north of Edinburgh or west of Chichester. When France fell, giving the enemy a chain of aerodromes many miles nearer the British coast and extending westwards as far as Brest, it became necessary to re-orientate the whole scheme of Britain's air defences. This was done, and today Britain's fighter defences look all ways and are controlled by an organisation of which de-centralisation, designed to allow the maximum of initiative to sub-formations, is the keynote.

If the Command Headquarters should become cut off from its ancillary Groups and Sectors, the efficient operation of the fighter defences would remain virtually unaffected. Group Headquarters have been so planned that they would function independently of the Command Headquarters while, farther down the line of organisation, Sector Controllers, cut off from their Group Headquarters, would still retain a full knowledge of what was taking place in the area under their supervision and would be able to deal directly with enemy machines threatening their territory. The efficiency of this system of de-centralisation was clearly demonstrated during the days of the Battle of Britain when lines of communication were frequently interrupted by enemy bombing.

The dispositions made and control and communications organised, there remains—to complete the system of air defence—the need for accurate advance warning of the approach of enemy aircraft. As the defending fighters have to leave the ground and climb to the height at which the raiders are flying, the warning must be adequate. To enable a suitable force to be deployed and directed towards an interception, there must also be accurate advance information of the strength of the raiding formation, its course, and the approximate speed of its approach.

This warning and this information Fighter Command obtains in a variety of ways, notably through its radiolocation stations and through the Royal Observer Corps whose members, watching the skies from a thousand posts in all parts of the country, record the movement of enemy aircraft within their orbit and flash the news of their progress to those who control the operations of the fighter squadrons.

In operations rooms at Sectors, Groups and at Fighter Command Headquarters this correlated information of the enemy's approach is recorded by symbols on a table map, the tracks

Britain owes much to the vigilance and skill of members of the Royal Observer Corps. This is a typical observer post.

The New Zealand fighter pilot on chair at right had just been shot down, baled out and is telling his pilot mates about it.

Modified to carry bombs for fast, low-level attacks, this version of the Hawker "Hurricane" is known as the "Hurribomber." It carries ten guns.

of the hostile planes and the approximate strength and height of the raiding force being shown. The group table gives, of course, a wider picture of the distribution of the enemy's attacking forces than the table at a Sector, which is concerned only with the smaller area directly under its protection. It is for the group commander, assessing the threat to his territory as a whole, to bring into action, if need be, squadrons from sectors other than those which may already be engaged or, if the strength of the raid demands it, to call for immediate reinforcement from neighboring Fighter Groups.

At Command Headquarters the picture widens still further and the Command table-map conveys at a glance the enemy's strength over the whole country. At this headquarters, as at those of the various groups, are liaison officers of the Navy, Army and Ministry of Home Security, the latter controlling the civil defence services of the country. The balloon barrage, the antiaircraft gun and searchlight defences, the RAF Bomber and Coastal Command, are also represented by their liaison officers who are in direct communication with their various headquarters. Each has his essential part to play, for upon the rapid sifting of information and the co-ordination of guns, searchlights, balloon barrage and other civil defence services depends the efficiency of the counter-measures which the Command initiates.

The first counter-measure will be the dispatch of a fighter force to intercept and engage the approaching enemy formations. The strength of the enemy force, the significance of the line of approach and the probable target are quickly interpreted by the operational controllers. From that interpretation will follow a decision as to the number of fighters likely to be needed to counter the raid and the fields from which they can best be drawn to give a tactical advantage. The utilisation of a balloon barrage to divert the line of attack, and by night, the co-ordination of antiaircraft gun batteries and searchlights separately or in conjunction with fighter aircraft, are other factors which the controller must take into account and upon which he must make decisions.

In the Sectors from which the defending fighters have been sent into action, the Sector controllers direct their forces towards interception of the enemy. Before each controller is the table-map recording the changing progress of the raiding formation—its height, speed, course and strength. In radio-telephonic conversation with the leaders of the fighter squadrons, he orders them on to a course and height which will bring them within sight of their opponents and in such a position that the strategic advantage will be theirs when the interception is made. He will, for instance, so manœuvre them that, if possible, they launch their attack from out of the sun or from above and behind the enemy formation.

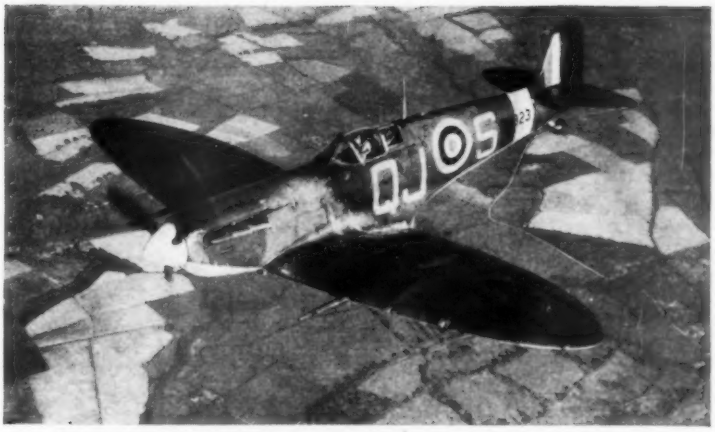
Once the enemy is sighted the controller's work is done and the leader of the fighter formation takes over. Summing up the strength and disposition of the enemy force, noting the types of aircraft of which it is composed, and searching the skies for the ambush that may be waiting up above, he decides the form the attack shall take. Over the radio-telephone he issues his orders to the pilots behind him. The formation splits up, each unit concentrating on the role assigned to it, and the battle is joined.

The same reporting and plotting system which brings the fighter and antiaircraft gun defence into action is also the basis for the mobilisation of the country's civil defence organisation. The air raid sirens that warn the public to take cover are sounded upon instructions from Fighter Command. From the advance information at its disposal the Command is able to assess the route of approach and the probable area of the main attack. With a minimum of delay, the civil defence

Formidable as a night fighter, the Boulton Paul "Defiant" has a four-gun power-driven turret.

authorities, warned by their liaison officers with the Command, are enabled to set into motion their plans for moving reserves of fire-fighters and rescue workers to the threatened areas.

This speed in the communication and exchange of information, so essential to the successful interception of enemy air forces, applies equally to the success of the Command's liaison with the naval and military forces. On one occasion, for example, a night fighter pilot on patrol over southern England reported by radio that an Army convoy moving along a road was showing more light than was desirable. The information was passed by Fighter Command to its Army Liaison Officer who in turn relayed it to the Army Commander of the area concerned. The leader of the convoy was contacted by wireless as he drove along and within 10 minutes of sending out his original message the patrolling night fighter pilot was able to report that the lights of the convoy had been adequately dimmed.



Vickers "Spitfire" currently in use by Fighter Command has two 20 mm. cannon and four machine guns. Earlier model had eight machine guns.

On another occasion a Fighter squadron was on a routine patrol when the naval authorities at a port some 80 miles away reported that a German bomber had slipped in and was "inconveniencing" shipping in the Thames Estuary. The Controller ordered the squadron off to deal with it and the bomber was shot down into the sea. The squadron leader reported its destruction to the Controller who, within 15 minutes of receipt of the original report, was able to tell the port authorities that the bomber had been disposed of.

In surveying the work of Fighter Command over the past two and a quarter years of war it is necessary to distinguish between day and night fighting. Each is a separate battle, with its own problems and its own technique. The Command's day fighting activity may be said to date from May and June, 1940, two months which saw the dispatch of two fighter squadrons to Norway and the beginning of the Battle of France. Until then there had been little operational activity over the United Kingdom either by day or by night, though the Command had made good use of the lull to train and build up its strength in men and machines in readiness for the storm that was about to break. In that invaluable breathing-space a substantial increase was made in the numbers of *Spitfire* and *Hurricane* fighters, of both of which types Fighter Command had all too few when the war began in 1939.

It was their superiority of numbers, though not of quality, which helped the enemy to attain their quick and startling successes in Norway and in France. Though Fighter Command sent a large proportion of its available fighter force to France so long as air bases were to be found there, leaving only a very thin air defence at home, it could not redress the balance, and throughout the Battle of France the allied air forces were greatly outnumbered.

Then came Dunkirk and the first opportunity for Fighter Command to employ its full organisation against the enemy—albeit at a disadvantage because of the long range at which the battles had to be fought. Yet Dunkirk, disastrous though its implications were, was the first decisive victory of Fighter Command over the Luftwaffe. Despite the odds in favour of the enemy, Fighter Command succeeded in establishing and maintaining local air superiority, and the success of the Dunkirk evacuation was in no small measure due to the protection afforded by our fighters. Fighter Command suffered heavy losses which it could ill afford in the course of that operation, but the enemy's losses were still greater and the Command achieved its purpose. In those two months of May and June which saw the true start of day fighter operations Fighter

One of the deadliest fighters in the RAF is the twin-engined Bristol "Beaufighter." It carries four cannon in the nose, in addition to several machine guns. "Beaufighters" are well liked in Middle East.

These are two of a "Hurricane's" four 20 mm. cannon. This model "Hurricane" excels in shooting up shipping and trains.

Command destroyed 500 enemy aircraft for the loss of 205 of its own pilots. Superior numbers, it seemed, could not command success in the face of superior quality of men and machines.

After Dunkirk, instead of sending his air force against Britain, Hitler turned it to the final subjugation of France. Historians may decide that this was the German Fuehrer's first big strategical error. That period of recuperation gave Fighter Command an opportunity to build up once more its depleted formations. The opportunity was seized. While factories worked day and night to produce *Spitfires* and *Hurricanes*, the resources of Bomber and Army Co-operation Commands were drawn upon to increase the number of fighter pilots. Quickly the fighter squadrons were built up anew and when the Luftwaffe again resumed its offensive against Britain, Fighter Command was back to the same strength as it had been at the beginning of May, before the Battles of France and Dunkirk.

Then came the momentous days of August and September, 1940,—the days of the Battle of Britain. They began with the Battle of the Aerodromes—when the Luftwaffe, having failed to defeat our fighters in the air, sought to destroy them on the ground and to make untenable their bases in southeast England. Fighter Command's system of dispersal and the flexibility of its carefully-planned scheme of ground organisation successfully countered that attack. There followed, in September, the Battle of London, a last supreme effort by the Luftwaffe to achieve its immediate purpose by reducing the capital to ruin.

Fighter Command tasted victory in those two decisive months—180 German aircraft brought down on August 15th, and in the whole month, 957 destroyed by fighters alone; 185 destroyed in one day on September 15th, and this for a loss of only 25 British aircraft and 14 of their pilots. Altogether, in the Battle of Britain, 2,375 German bombers and fighters were destroyed. The losses of Fighter Command were 375 of its pilots killed and 358 wounded. As the Battle passed its zenith, the daylight raids by German bombers became fewer, while the proportion of fighters in the enemy formations increased until soon only fighters carrying small bomb loads and flying high were coming over. The day bomber had proved too vulnerable to fighter attack to be risked further.

The day bombing of Britain on any appreciable scale ceased in October, 1940, and has not since been renewed. Instead, the Luftwaffe has contented itself by day with "nuisance" policy of tip-and-run raids by single bombers, usually on coastal objectives. A large scale night offensive, which began in October, 1940, and continued throughout the winter, was the next phase of operations, and while it lasted most of the Command's operational activity was by night.

The onset of this new offensive found Fighter Command deficient in the appropriate types of aircraft and equipment and its personnel inexperienced in the special technique that is required for interception and engagement at night. Successes were few at first, but gradually the new art was mastered. The British pilots began to see the night raiders, to fight and to destroy them. Three were brought down by fighter action in January and five in February. As experience grew and the night fighter force was strengthened, victories mounted rapidly. The "bag" for March was 21 night bombers destroyed. This score was more than doubled the following month when 50 raiders were brought down, and was multiplied by five in May when 106 of the Luftwaffe's bombers fell to the guns of the Command's night fighter pilots. This was apart from the many others brought down by antiaircraft gunfire. On the night of May 10, 1941, 33 night raiders were destroyed, 29 by fighter action and four by antiaircraft guns.

That night marked the end of the Luftwaffe's big-scale night offensive. Since then the enemy's night effort against Britain has dwindled to occasional "retaliation" attacks by 100 or more aircraft and to sporadic raids by smaller formations. Of these a greatly increased and strengthened night fighter force takes regular toll.

Meanwhile, the Command's day fighter force had not been idle or neglected and by January, 1941, was strong enough to take the first steps towards gaining the initiative by offensive patrols on a small scale over the German-occupied territory of northern France. Bombers, strongly escorted by fighters, were used on these offensive missions. In May, 1941, Germany transferred the greater part of her air fleet to the Russian front, intending to leave very little in the west. The Luftwaffe continued to make occasional "nuisance" raids with small numbers of bombers, usually at night and against coastal towns, and to harass coastal shipping, but day or night raiding on any great scale had by then altogether ceased.

The time was now fast approaching when Fighter Command would be in a position of sufficient strength to launch a counter-attack in real earnest. That day came in June, 1941, when there began a full-scale daylight offensive which, except only when weather conditions have been prohibitive, has been maintained ever since and has now, with the recent start of

An eight-gun "Hurricane" has its .303 calibre machine guns reloaded. Guns and their ammunition are carried in each wing.

Back from a sweep, the fighter pilot hasn't time to get out of the cockpit before a ground crew starts servicing the ship.

Sergeant pilots at readiness in the crew room of a Fighter Station. This station alone claimed 600 enemy aircraft destroyed during the Battle of Britain. These men helped save England from defeat.

the 1942 Spring offensive, been stepped up to an intensity of fighter attack as yet unprecedented.

Beginning with small-scale attacks on the other side of the Channel, Fighter Command gradually increased the weight of its offensive. Today formations of fighters two to three hundred strong are frequently employed on a single operation. The immediate result has been the achievement of a fair degree of daylight supremacy over the greater part of the enemy occupied territory within effective range of the Command's home-based fighters—and certainly supremacy over the North West corner of France, from Ostend to Dieppe and above the Cherbourg peninsula. So long as this supremacy is maintained—and it is the short range fighter which determines it—bomber forces can be escorted by fighters to daylight attacks on important objectives in the occupied territories. Docks, harbour installations, power plants, and armament factories linked to the German war effort can be sought out in daylight and attacked with a degree of accuracy rarely possible by night and with a bomber force virtually immune to attack by enemy fighters.

If not to counter, at least to seek to parry this ever-mounting offensive, the Luftwaffe must stretch its fighter forces to the limit, thereby fulfilling the chief object of the British air offensive—to open up a second air front in the west and relieve the pressure on Russia by keeping engaged the greatest possible number of German aircraft. Since the summer of 1941, the Fighter, Bomber and Coastal Commands of the RAF have, by their joint offensive, kept more than 50 per cent of the Luftwaffe's total fighter force pinned down in the west. To meet the greatly increased weight and tempo of this offensive calls for either a sustained effort beyond the endurance of the present German fighter force in the west or for the diversion of substantial reinforcements from the Russian front. If the latter course is followed the enemy may jeopardise his campaigns in the east; while if he concentrates his air strength on the Russian front, British air mastery in the west will be assured, with the attendant risks of an Allied mechanised force landing in France under the same protective air canopy as made possible the capture of Singapore and Java by the Japanese. And if the Russians are themselves able to establish a measure of air superiority over some parts of their front, the result of this splitting of the enemy's fighter strength will be to throw the Luftwaffe on the defensive in both west and east.

Bristol "Beaufighter" crews play "Put and Take" in their dispersal hut while awaiting orders to fly against the enemy.

The offensive phase which Fighter Command entered upon last June and is now pursuing daily with ever gathering momentum has naturally called for tactics entirely different from those successfully employed during the Battle of Britain. As the result of experience and constant experiment, two principal methods of daylight attack have been evolved—the first, high level attacks with the uppermost squadrons flying at heights of 30,000 feet or more; and the second, low level attacks relying mainly on the element of surprise. The two forms of attack lend themselves to a variety of offensive operations and tactical dispositions. Adaptations of the high-flying attack are employed in the large scale fighter "sweeps" of the enemy territory and to the great combined fighter and bomber operations. Low-flying attacks may range in form from diving attacks on enemy ships or land strong-points by cannon-equipped or bomb-carrying fighters to small-scale harassing operations by fighters making use of cloud-cover or sea-level approach to surprise the ground defenses.

Though tactical dispositions cannot here be described in any detail, some idea of their complex character is afforded by an outline of a large-scale combined fighter and bomber operation. Several hundreds of fighters with a squadron of high-speed bombers may be engaged in one such operation, the

Off for convoy patrol duty, these "Hurricanes," in addition to "Spitfires," have been assigned to protect as many as 18 convoys in one day.

programme for which will have been worked out in advance to the last detail and to a time schedule calling for minute-hand punctuality. The pilots, both bomber and fighter, will have been carefully briefed in the parts they are to play and in the route and heights to which they must adhere. Fighters and bombers take-off from their respective airfields and, having attained their allotted heights, converge upon a given rendesvous to take up their pre-determined places in the formation.

With the bombers in the centre and the protecting fighter squadrons stepped up in tiers, the "beehive" heading out across the English Channel may extend to a sky depth of 10,000 feet and cover a horizontal distance of more than a mile. Each fighter formation—high cover, rear support, close escort and so on—has a specific role assigned to it and a duty which it will perform until the bombers, having gained their objective and dropped their bombs, have come back across the Channel and the formations have dispersed to their various bases.

Since Fighter Command began its present intensified offensive, six, seven or eight major operations in one day between dawn and dusk, have been frequent occurrences.

The daily balance of results is sometimes against the Command, though more often in its favour. More significant than any daily counting of heads however is the fact that from January, 1941,—when Fighter Command first took the offensive—to May 1st, 1942, its pilots destroyed nearly 1,000 enemy aircraft in daylight on the other side of the Channel. Its own daylight losses during the corresponding period were 644 aircraft, 76 of whose pilots were saved.

The man at the telephone has just received an action warning. The orderly presses button to sound bell in pilots' hut.

These casualty figures are very different from those of the Battle of Britain period. In those days the Luftwaffe on the offensive over this country was losing its aircraft in the proportion of three to every one of ours brought down. Fighter Command on the offensive over the enemy's territory has so far succeeded in maintaining a balance in its favour in the ratio of nearly two enemy aircraft destroyed for every one of its own lost.

The very nature of offensive operations, involving fighting for the most part over hostile territory where even a bullet in the engine cooling system may mean a forced landing, must inevitably bring heavier losses than will be incurred on the defensive. Pilots who may be forced to take to their parachutes are no longer assured, as in the Battle of Britain, of landing on friendly soil ready to fight again.

Fighter Command's offensive policy has not been confined to daylight hours. Starting first on a small scale and steadily increasing in weight and scope, night attacks have been carried out regularly for the past 18 months. Now, each night that weather permits, enemy aerodromes in the occupied territory are bombed by fighter-bombers of the Douglas *Boston* type. In addition, whenever the enemy shows signs of activity by night, our fighters patrol his aerodromes at the time when his bombers are taking-off or returning to land. Not only are many Luftwaffe raiders destroyed in this way both in the air and on the ground, but the constant menace of these patrols and the disorganization they cause must inevitably have a most adverse effect on the morale of the Luftwaffe's bomber pilots and ground crews. Fighter Command's policy is to hit the Hun as hard and as often as possible by day and by night, and as the last squadrons of day-fighters come sweeping back from France in the dusk, the first night fighter patrols will be making ready to take over and carry the war to the enemy through the hours of darkness.

The air protection of British shipping in coastal waters is another duty laid upon Fighter Command and one so vital to the joint war effort that it must be constantly and effectively performed. Every convoy and naval escort that leaves or enters a British port comes under the protection of fighter patrols, and throughout the daylight hours, so long as weather permits, fighter escorts, operating in relays, are in close attendance upon a convoy until it is safely in port or has been passed out of fighter range into the care of the long range airplanes of Coastal Command.

The scale of this little publicised effort of Fighter Command may be gauged by the number of sorties made in the course of convoy work—a sortie being a single flight by one aircraft. In the 12 months of last year these totalled approximately 55,000—an average of 153 sorties a day. In one month alone, over 8,000 sorties were made by fighters in the escort of shipping, and as many as 18 convoys have come under the protection of Fighter Command in a single day. These sorties were additional in all cases to the Command's normal daylight offensive and night defensive operations.

Fighter protection of coastal shipping has proved highly effective. From the spring of last year, when it first became possible to step-up the scale of air protection to its present high level, the enemy's air attacks on shipping steadily declined and our shipping losses fell in consequence. From 200 in March, 1941, daylight air attacks on coastal shipping dropped to 105 in May, and in that month our daylight shipping losses fell by two-thirds. June saw our losses halved again, and by last December the number of daylight attacks on coastal shipping had fallen from the 200 in March to only 30, a decrease of nearly 50 per cent compared with the previous month and the lowest number since February, 1941. The best result the Luftwaffe could show for the last six months for 1941, was an average of less than one ship a month sunk by air attack in daylight. And against this meagre result the Luftwaffe had a reckoning of its own to set—in the last five months of 1941, 42 of its shipping raiders had been destroyed, 24 by gunfire from merchant ships and naval vessels and 18 by the fighter escorts; while in the first two months of 1942, when

A squadron of old Gloster "Gladiators," flying from a frozen lake in Norway, put 16 faster German bombers out of action.

the enemy effort against coastal shipping temporarily flared up again without corresponding result, 10 more raiders were destroyed, seven of them by fighter action.

Opportunities for combat are eagerly seized upon by the fighter pilots as welcome breaks in the monotony of their endless patrols, but their victories are, in fact, only incidental to their main purpose. Convoys of fighter escorts, by their presence alone, serve as an effective deterrent to enemy air attacks. Already the protective effort put forth each day by Fighter Command has forced the enemy more and more to keep away from coastal shipping by day and to restrict his attacks to darkness or dusk when, though the chances of a successful direct attack are greatly reduced, fighter opposition must necessarily be less effective.

In the past 12 months the number of daylight attacks, as compared with those delivered at dusk or by night, has shown a substantial average reduction. In March, 1941, 82 per cent of the Luftwaffe's air attacks on coastal shipping were made in daylight. By May, the figure had dropped to 40 per cent, by September, to 20 per cent, while by December, only 18 per cent of his attacks were being delivered during daylight hours. The percentage rose again in the first two months of this year, coincident with the temporary increase in the enemy's effort against coastal shipping, but has since declined to its former low level. Meanwhile, the long lines of the United Nation's convoys, their volume unabated, continue to stream past the coasts of Britain or thread the narrow Straits of Dover in daylight beneath the protective screen of their fighter escorts.

In the course of all these widespread and diversified operations Fighter Command and its allied antiaircraft defense organisation has been responsible for the destruction of a total of some 4,679 enemy aircraft up to May 1, of this year. Fighters alone have shot down 4,312 of these for the loss to themselves of approximately 1,769 aircraft and 1,268 pilots. By night over the same period a total of some 630 enemy raiders have been destroyed in flight.

To turn now to the airplanes that have been called upon to achieve this result, it is perhaps not generally realised that Fighter Command's chief equipment at the outset of the war consisted of Gloster *Gladiators*—an obsolescent single-seater biplane fighter with an air-cooled radial motor. *Spitfire* and *Hurricanes*, proven types though they were, were all too few, and it was only by dint of the most strenuous effort that it became possible to re-equip the fighter squadrons with these two more modern types in time for the Battle of Britain.

Both types have since been greatly and consistently improved and in their latest forms are still the mainstay of the Command's day fighting force.

Perhaps the most noteworthy feature of British fighter development since the war has been the adoption of the cannon on both day and night fighter types. It is a policy which has been abundantly justified by war experience. Since the Command's *Spitfire* and *Hurricanes* were re-armed with cannon, either as sole armament or in conjunction with machine-guns, the number of enemy fighters destroyed has been greatly increased.

The cannon fighter, in fact, may be termed the dive-fighter of the Command, the reply to the dive-bomber. It can indeed, be argued that it can do more than its rival. A bomb does damage where it falls, but cannon-fire makes possible the infliction of more widespread and no less effective damage by a smaller number of less vulnerable aircraft.

Cannon-equipped fighters have also proved most successful in night interception, which is generally of such brief duration that maximum hitting power must be brought to bear in the few seconds available. In daylight use against the enemy's fighters, cannon-fire has a truly devastating effect and there have been several instances in which aircraft so hit have been seen to disintegrate immediately. "It was like having an ash-can emptied in your face," was the graphic description of one fighter pilot who saw a Me-109E break up under his cannon-fire and was obliged to dive clear of the debris.

Fighter Command has also developed its own fighter-bomber, in the form of a *Hurricane* fighter equipped to carry two 250 pound bombs, one under each wing-root. These fighter-bombers, making good use of a low-level approach to surprise the ground defences, have proved highly successful in attacks on enemy aerodromes and other objectives in the occupied territories across the Channel. Once relieved of its load the bomber turns fighter, able to defend itself against air attack or to carry out machine-gunning attacks.

Of the Command's night-fighter types, the standard airplane at the outset of the war was the twin-motored Bristol *Blenheim*. Later, our night defences were reinforced by the single-motored Boulton Paul *Defiant*, a tandem two-seater monoplane in which the rear gunner is armed with four machine-guns in a power-operated turret.

Among the new fighter types produced since the war, one of the most successful has been the Bristol *Beaufighter*, a twin-motored low-wing monoplane with a maximum speed in excess of 330 m.p.h. and an armament of four cannon and six machine-guns. This airplane, one of the fastest and most heavily-armed fighters in existence, has a long and remarkable record of successes in night actions. Suitably equipped *Spitfires* and *Hurricanes* also play their part in the Command's night fighting force and many of the Command's most successful night offensive operations over enemy territory have been carried out by Douglas *Havocs* (modified DB-III's) whose high speed, useful bomb-load and good handling qualities are admirably fitted to this type of operation.

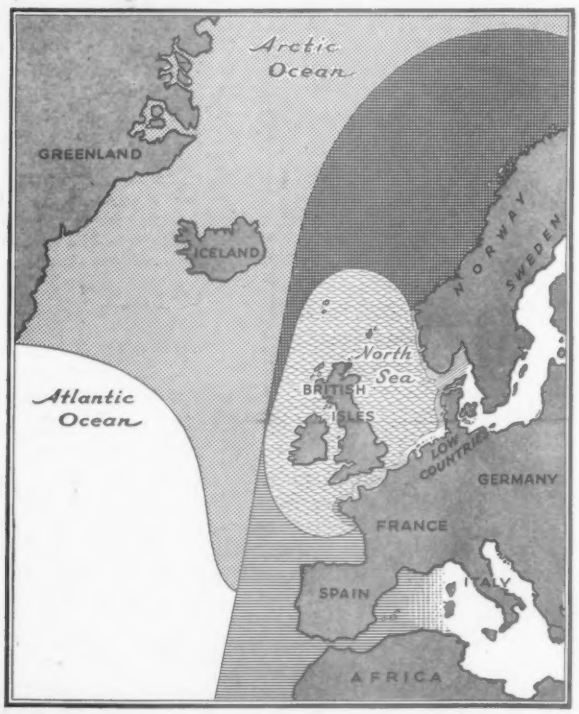
With these proved types and others of more recent design Fighter Command is launching its offensive on a scale such as no country has equalled. It is an offensive whose peak is not yet in sight, but one which will steadily grow as the production of American and Canadian factories swells our own, and as airmen cross the Atlantic in their tens of thousands to fight beside those of Fighter Command on the second front which the RAF has already opened in the west.

END

An RAF fighter caught this new Dornier Do-217E, shot it down for British engineers to dissect. It has two 1,580 h.p. engines, range of 1,500 miles at 255 m.p.h.

COASTAL COMMAND

A Coastal Command "Sunderland" circles a convoy from the United States.



This is the area patrolled by Coastal Command during the first seven months of the present war.

This area was added following the invasion of Norway and Denmark.

Following invasion of the Low Countries this area was added.

Increase in range of aircraft added this area. Coastal Command now covers 5½ million square miles.

by P. B. Joubert

AIR CHIEF MARSHAL SIR PHILIP B. JOUBERT, K.C.B., C.M.G., D.S.O., P.S.A., Air Officer Commanding-in-Chief, Coastal Command, played a big part in the development of radio-location now so vital to Allied defences. He was born in India in 1887, attended school in England and joined the Royal Artillery in 1907. He entered the Royal Flying Corps in 1913, later graduated from the RAF Staff College, which he subsequently commanded. In 1934 was A.O.C. Fighting Area—then became C. in C. Coastal Command before returning to India as A.O.C. He was recalled from India in October, 1939, and is now again A.O.C.-in-C. Coastal Command.

IN 1918, the Coastal Command of the RAF contained many hundreds of aircraft of various types which were engaged in the protection of our convoys, in reconnaissance for enemy sea forces, and in attack on U-boats. When peace was declared and the grim spectre of war was thought to have been banished, these coastal forces shared in the general reduction. They dwindled indeed to a few flying boats, some torpedo bombers and the shore-based organisation which supported the carrier-borne aircraft—then manned by the RAF.

But the British are essentially a seafaring nation and before long the need for maintaining an adequate force of aircraft in support of our Navy became more clear. Hence the Coastal Area Royal Air Force, as it was then called, gradually built up its strength both in shore-based and in carrier-borne aircraft.

The manning of aircraft carriers with RAF personnel led, however, to administrative inconveniences and agreement was eventually reached between the Air Ministry and the Admiralty that the recruiting and manning of what was then

Powerful Coastal Command weapon is the Short "Sunderland" flying boat. It has four 850 h.p. engines.

Britain's shores depend for much of their safety on the ever-alert eyes of the Coastal Command airmen. Its aircraft patrol more than five million square miles of ocean.

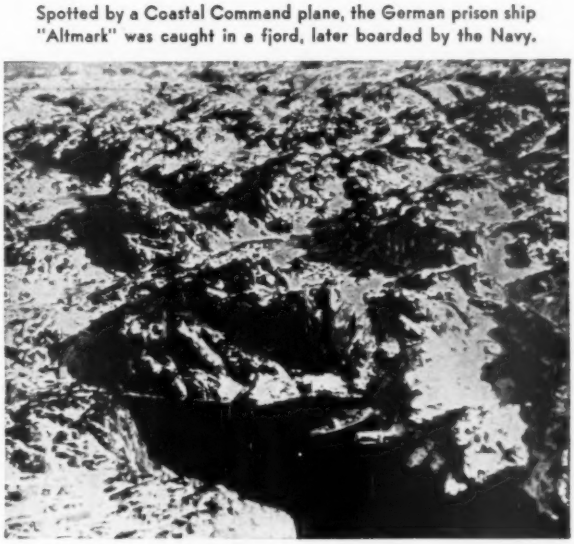
known as the Fleet Air Arm, comprising carrier and ship-borne aircraft, should be the responsibility of the Admiralty, the Air Ministry remaining responsible for the provision and manning of all shore-based aircraft, whether flying-boats or land planes. About this time, too, Coastal Area became Coastal Command.

The period from 1936, until the war broke out was one of considerable development in Naval air co-operation. As an example, the principle of an Area Combined Headquarters in which Naval and Air Force officers sit side by side working out the combined scheme of operations was instituted for all the principal Naval commands in Great Britain. The working of these Area Combined Headquarters today is an indication of the close co-operation that exists between the Royal Navy and the RAF.

Since the outbreak of war one other change in organisation has been made to ensure even closer co-operation between the two services. At the beginning of 1941, it was agreed that Coastal Command, while remaining a Royal Air Force Command, should come under the operational control of the Admiralty. This in practice means that the general policy direction of operations by Coastal Command over the sea is in the hands of the Admiralty, while the carrying out of those directions is the responsibility of the commander-in-chief, Coastal Command. In addition the commander-in-chief is directly responsible to the Air Ministry for the conduct and general efficiency of his squadrons. The composition and the numbers of these squadrons are determined by discussion between the Admiralty and the Air Ministry. It is therefore clear that the strength, the scope and the policy of Coastal Command are the result of agreement between the Air Ministry and the Admiralty.

Attacking from a height of 50 feet, this Coastal Command "Blenheim" hit and sank a 2,500-ton enemy ship off Norway.

Spotted by a Coastal Command plane, the German prison ship "Altmark" was caught in a fjord, later boarded by the Navy.



One of Coastal Command's deadliest aircraft is the Bristol "Beaufort" torpedo bomber, shown receiving its "tin fish."

Because, for reasons of policy, the Battle of the Atlantic must be fought in silence, the magnitude of the work of Coastal Command is not often realised outside the services.

Upon the outbreak of war, Coastal Command no less than other commands of the RAF at home and overseas, was inadequate both in strength and modern equipment for the vital role that air power was to be called upon to play.

Of its few flying boats the Short *Sunderlands* were the best. Its land-based aircraft were Avro *Anson* reconnaissance bombers, slow and not well armed, and some Vickers *Wildebeest* torpedo-carrying aircraft, which had soon to be replaced by Bristol *Beauforts*.

The Command had, however, two assets of incalculable worth—a nucleus of air crews who were among the most highly trained and efficient in the world; and a staff which had devoted the years of peace to preparation for the special problems of an air-sea war, a staff led by the then Air Officer Commanding-in-Chief, Air Chief Marshal Sir Frederick W. Bowhill, K.C.B., C.M.G., D.S.O. Sir Frederick Bowhill has a rare knowledge of the sea, both from the air above it and from the surface (he is a master mariner, qualified in a square-rigged ship, a distinction now held by few). Later in the war he was chosen to take charge of the ferrying of aircraft from America to Britain.

Thus with its little fleet manned by a small but remarkably efficient body of officers and men, Coastal Command was thrown straight into the war from the minute of its declaration. There was no nine-month interval of "phoney" war for this Command. In that first period the Germans rarely gave battle, so Fighter Command had little to fight. Bomber Command was confined to the attack on shipping and to those long-ranged leaflet raids which were invaluable as preliminary training.

But on the first day of the war, Coastal Command leapt straight into its tasks of protecting shipping and reconnaissance. The war was scarcely a few hours old when a Coastal Command aircraft sighted and attacked a submarine. In the first month of war its aircraft found and attacked more than a score of U-boats. On the first day of war a particular reconnaissance brought from the chief of the Naval staff a request for the special commendation of a pilot.

To carry out its task effectively the Command was divided into several groups, each covering a specified stretch of the coastline of Britain and radiating into the seas beyond. Each group was subdivided into a number of stations, at each of which were based one, two or more squadrons. Most of the stations were in remote coastal districts, several of those in the north being on the lonely islands that cluster round the coast—the Scottish Isles, the Shetlands and the Hebrides. Coastal Command headquarters worked in close collaboration with the Admiralty, and the groups with the various Naval commands. The aircraft from the stations flew over the shipping convoys, and dovetailed their work with that of the escorting destroyers.

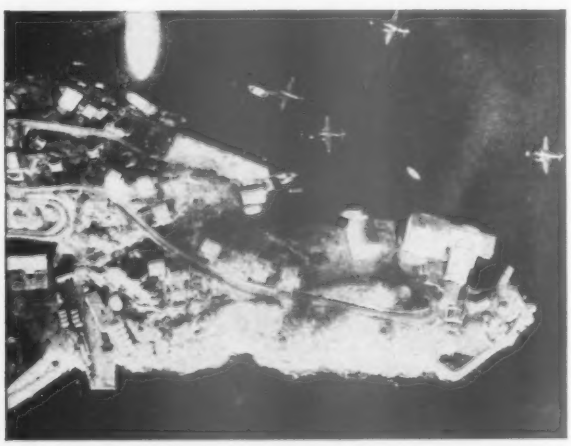
As the war developed and changed its character, the functions of Coastal Command changed. Increases in the area over which it fought were forced upon it by new strategic situations and new tasks were laid on its shoulders. While Norway was neutral the task of reconnaissance in the northern part of the North Sea was not very difficult. The *Altmark* incident is a good example of the work of our scouting aircraft at that time. This ship, which carried 400 British seamen prisoners destined for a triumphal parade through the streets of Berlin, was located by Coastal Command aircraft, thus enabling H.M. destroyer *Cossack* to board her in a Norwegian fjord and rescue the prisoners.

Caught in the harbour at Bergen, Norway, these Nazi supply ships and transports were successfully bombed by the RAF.

But events swept on to the Norwegian invasion. Coastal Command aircraft, still few in number, worked unremittingly to report every northward movement of German supply vessels and warships. The flying boats made flights of unbelievable length, reporting and carrying important messages and persons.

Norway, however, was lost. Immediately, a serious new problem faced Coastal Command. German short and long range fighters now had bases on the Norwegian coast. Reconnaissance in that area, formerly placid, became subject to fierce opposition. Moreover, the British east coast shipping, which before had risked only U-boat attack, was now exposed to air attack as well.

Fortunately, Coastal Command had been developing squadrons of long-range fighters. These were Bristol *Blenheim* aircraft, emptied of bomb load and fitted instead with a bank of machine guns beneath the fuselage. Now they came into



These four Heinkel He-115 seaplanes anchored at Bergen were sunk by Coast Command bombs (upper left corner of picture).

play and did magnificent work far out over the North Sea, outside the endurance of single-engined fighters.

When in May, 1940, the Germans swept into Holland and Belgium it was largely American-built aircraft which solved for Coastal Command the problems that arose. It had been recognised long before, of course, that the Command urgently needed strengthening and this had been accomplished in two ways.

The *Wildebeests* had given place to *Beaufort* aircraft, the speed and power of which gave them a triple function—torpedo-carrying, bomb-carrying, and mine-laying. In addition a reasonably large reconnaissance force of Lockheed *Hudson* aircraft had been built up.

These squadrons were diverted from reconnaissance work and formed into a striking force. Helped by the *Ansons*, which proved to possess amazing powers of fighting and bombing, and by *Beauforts* carrying bombs, the Lockheed *Hudson* force was turned on to the German occupied Dutch ports. They fought off superior numbers of enemy aircraft which tried to interfere with our own or with the Dutch naval operations; they shielded sea evacuations from the Netherlands and from Belgium; and then they returned by night to attack material of military value which had been left behind. In particular, they directed their bombs against oil. One *Hudson* squadron was detailed to deal with the oil installations at Rotterdam alone.

June brought the German break-through in France, and the evacuation from Dunkirk. As the Battle of France merged into the Battle of Britain the war as seen by Coastal Command today gradually took shape. The new situation was conditioned by the German occupation of the whole European coastline from the North Cape to the Franco-Spanish border. With U-boat bases not only to the north in the Dutch islands but also to the south along the French coast, the Battle of the Atlantic was grimly intensified. And added to the U-boat threat was that of the long-range Focke-Wulf bombers which roamed from the southwest coast of France to Norway seeking out the vital Atlantic shipping convoys.

In this phase again American-built aircraft came to the aid of Coastal Command. Squadrons of Consolidated PBY flying boats, known to the RAF as *Catalinas*, had been built up. These flying boats, with their phenomenal endurance, have played a part in the war against the U-boat which cannot now be fully told, but which nevertheless will form a notable chapter of aviation history. In addition, the Consolidated *Liberator* four-engined bombers lent their aid to the British Vickers *Wellingtons* and Armstrong-Whitworth *Whitleys* and to the *Hudsons*, which were by then protecting the vital life-line of ships across the Atlantic.

Coastal Command "Hudsons" played a vital role over Dunkirk during that evacuation by the British Expeditionary Forces.

A Coastal Command Lockheed "Hudson" actually captured this Nazi submarine after the plane's bombs forced it to surface.

And so today Coastal Command's task has been determined, and can be summed up as follows. To the west, the vital task of protecting the sea routes; to the east, the equally important tasks of reconnaissance against invasion and striking the enemy's invasion ports and supply shipping; while, superimposed, there is the ever present task of preventing the German surface raiders from breaking out into the Atlantic.

Consider, now, how the changing facets of the war have always enlarged the area over which Coastal Command must fight. In the early stages it was not small, but it had very definite limits. It embraced the North Sea, the English Channel, the home waters to the west of Britain and the south-western approaches of the Atlantic, with a communications line to Gibraltar. With the invasion of Norway a great additional area of sea stretching up to the Arctic Circle was added. The German occupation of Denmark, Holland and Belgium did not extend the area of operations but it added hundreds of miles of heavily defended coastline to the operational liability of the Command. The German occupation of France completed the picture. To the south, the battleground was extended far down into the South Atlantic, practically to the equator, while to the north its area extended as far as the coast of Greenland and far beyond the Arctic Circle.

British forces moved into Iceland (to be followed soon afterwards by the Americans), and Coastal Command land and flying boat squadrons were posted to that northern island. To the west, where as the result of naval and air attack the U-boats were driven to operate farther and farther out into the Atlantic, Coastal Command had to range right out to the limits of the U. S. Navy patrol zone.

There was to be one more addition, the result of the opening of the Russo-German war. Coastal Command's area then curled round the northwest points of the European land mass to touch the north Russian battle fronts.

The present total area of Coastal Command's battle zone, over which the war is actively fought every day of the year, is more than *5,500,000 square miles.*

Flying over Norway in bad weather, this "Blenheim" came out of clouds onto a mountain, brought back a small bush in wing.

In covering that area, Coastal Command aircraft have now flown, on war operations, *50,000,000 miles*, a mileage more than half the distance from the earth to the sun. That is some indication of the endurance of the air crews. It is no uncommon thing for a Coastal Command flying boat pilot to have to his credit more than 2,000 hours of operational flying.

The worst enemy of Coastal Command—far more formidable than the Nazis—is the weather. It is rare that over some part of that vast battle area there is no gale blowing, no bank of fog to cover the landing ground or the home moorings. It is mere routine for a Coastal Command aircraft to face several hundred miles of sea in the teeth of a full gale. A flying boat in distress has actually put down far out in the Atlantic in an extremely heavy sea and floated for seven and one-half hours. As it sank the crew was rescued by a Naval vessel.

The number of hours since the war began when there have been no Coastal Command aircraft flying could probably be counted on a man's fingers. There have been occasions in winter when probably the only aircraft in the air over the whole of western Europe were those of Coastal Command on reconnaissance patrol.

A special—though by no means exclusive—function of the Command, and one which has been emphasised in the recent stages of the war, is that of attacking enemy shipping. Germany never offers anything like the sea target that Britain presents every day, but circumstances have forced the Germans to employ a certain amount of shipping in coastal traffic. The overloaded rail transport system of Europe has been badly damaged by RAF bombing, and sometimes by sabotage, while the needs of war have taxed iv far beyond capacity. In order to supply armies of occupation in the west, and now to supply armies in action in Russia, the Germans have been compelled to divert much of their transport to the coastal water routes, the dominant factor in this decision being the fact that one supply ship of 6,000 tons carries roughly the same amount at 10 long goods trains. Supply shipping started to show itself directly the Germans had occupied the European coast and as promptly the Coastal Command started to harry it.

The aircraft used are mainly *Beauforts* and *Hudsons*. At first the *Beauforts*, firing torpedoes, were the more successful. In a period of eight months from November, 1940, one squadron alone either sank or damaged beyond hope of repair 110,000 tons of German shipping.

But, meanwhile, a completely new method of attacking ships was being evolved. It was first employed most successfully by a Bomber Command group using bombs which were fitted with a delayed action of a few seconds. These aircraft attacked the ships from, at or below mast height. This method revolutionised the technique of shipping attacks. In addition to the many ships sunk or damaged by Bomber Command during early November, 1941, *Hudsons* of Coastal Command, in their attacks on German shipping supplying the Nazi armies in north Russia, hit (within a period of four nights) some 30 ships for certain, many of which are known to have sunk outright.

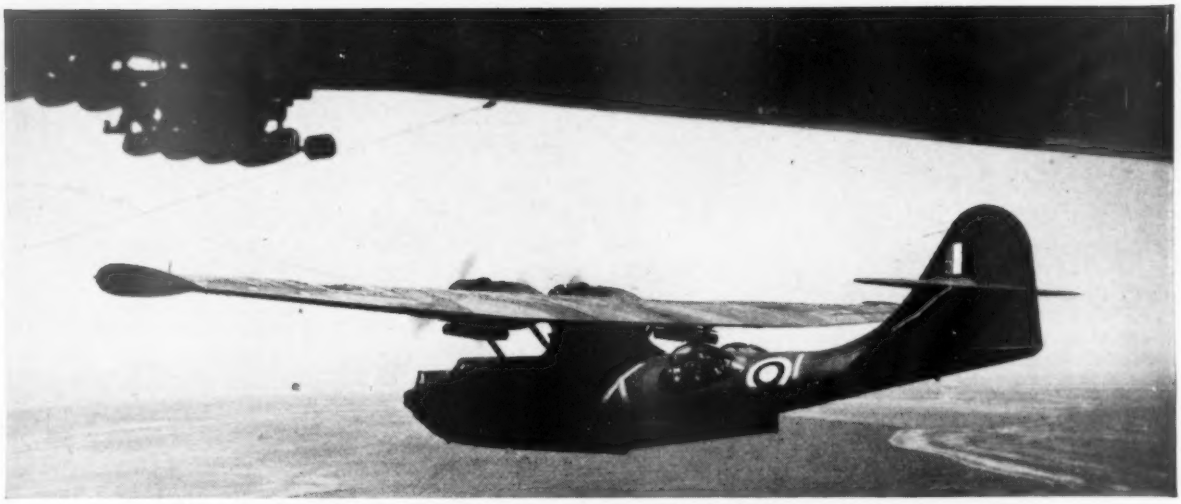
The attacks were made from so low a height that sometimes the air crews could hear (in spite of the noise of their engines) the thud of their bombs as they pierced the ship's deck. Sometimes the crews choked and spluttered from the smoke from the ship's funnels as it swirled through their aircraft. Sometimes they came home with splinters of wood embedded in the fuselage.

The German's took such a serious view of this type of attack that they began to provide heavy escorts of antiaircraft ships, sometimes destroyers, for their supply shipping. A single supply vessel has been seen escorted by no fewer than five "flakships." But even the curtains of fire—mostly quick-firing cannon shells and tracer bullets—which these ships put up have not deterred the Coastal Command pilots from pressing home their attacks from levels just as low and with results just as satisfactory.

There are many lesser tasks which Coastal Command is called upon to perform. One of them (to pick at random) is the ferrying of important officers and high officials to the various theatres of the war. For this task, flying boats are used—either *Sunderlands* or *Catalinas*. Another of their tasks is to patrol the ice far north of the Arctic Circle and along the remote coasts of Greenland, to report how the pack ice is moving or how the bergs are tending—information vital to the safe conduct of Atlantic shipping farther south. Long range Lockheed *Hudsons* carry out this duty from Iceland.

These are some of the tasks. The aircraft types with which they are carried out have all been named already, with one exception. That is the Bristol *Beaufighter*. This long-range fighter, of great power, and equipped with four cannon and

While raiding an Allied convoy, this Nazi Focke-Wulf "Kurier" was caught by a Coastal Command Lockheed "Hudson," shot down after a brief fight, then photographed. Note Germans swimming away from wreck.



Another very welcome U. S. type is Coastal Command's Consolidated "Catalinas." Plane in foreground carries depth charges under wing. Camera plane is carrying smoke floats (upper left-hand corner of picture).

six machine guns, has now practically replaced the *Blenheim* fighter on the establishment of Coastal Command. One of these aircraft literally blew a Junkers Ju.88 to bits with one burst of fire from its powerful armament.

Although Coastal Command aircraft and aircrews are now flying in the Middle East and the Far East, the main task of the Command is still, and will always be, the Battle of the Atlantic. This is the crucial battle of the war. It began on September 3, 1939, when some of the U-boats were already out at sea. It has been fought without respite ever since.

Secrecy must surround this battle. Experience in the last war, and in the early stages of this, showed clearly how potent a weapon is silence in regard to U-boat sinkings when directed against German submarine personnel.

The U-boat is the chief enemy. The Nazi U-boats hunt in packs, being directed to the British convoys on some occasions by scouting Focke-Wulf bombers. Once a U-boat has contacted a convoy it shadows it until the whole pack has come up. Then a mass attack is made at night.

Coastal Command aircraft, in taking their part in the Battle of the Atlantic, have therefore two duties with regard to U-boats. If possible, they must attack and sink them. But almost of equal importance is the keeping of them below the surface, thus dislocating their timetables and often enabling the threatened convoy to escape; for as the U-boats have been driven to hunt farther and farther out in the Atlantic, in order to reach their hunting areas they have had to increase their average speed and this has meant travelling on the surface by day as well as by night.

As for the first duty, that of sinking U-boats, it is permissible to say that Coastal Command aircraft have attacked several hundreds of U-boats and that there is good reason to believe that much damage has been done. The U-boat commanders take the most elaborate precautions to avoid detection by our aircraft and are really frightened of air attacks.

On one occasion in the Battle of the Atlantic a Coastal Command Lockheed *Hudson* forced a U-boat to surrender. This aircraft, together with a *Catalina* that relieved it, held the U-boat captive from the air for 11 hours until a Naval surface vessel could arrive to take over. Coastal Command aircraft then gave continuous air escort for the next 40 hours, during which time the Navy boarded the U-boat, removed the crew and brought the vessel intact into a British port with a prize crew aboard.

This was a highlight in the Battle of the Atlantic. There have been many such highlights, and many reverses. The battle itself, fought in the waters between the front line of Britain and the arsenal of America, is not yet decided. As the convoys increase in size and frequency, there is a demand for more and more aircraft. There always will be. For we can never have too many aircraft for this battle.

A *Catalina*, with its long endurance (its average flight is 18 hours) is a vast improvement, for this purpose, on a flying boat or land aircraft with shorter staying power. Two *Catalinas* are an improvement on one. A fifth *Catalina* might, perhaps, destroy a U-boat that four on patrol had missed. But to get them all we should need 10 . . . 20 . . . an unlimited number . . . . The area to search is so vast, the target to find so small. There cannot be too many.

Thus, just as Coastal Command looks westward when it fights its greatest battle, so it looks still farther west when preparing to continue the fight to the end. It looks to the aircraft factories of America. Every long range flying boat from those inexhaustible resources can be used in this Battle of the Atlantic and used well.

The Battle of the Atlantic is a battle of chances. There are Coastal Command pilots who have flown week after week, month after month, for more than two years and yet have never seen a U-boat. There are others who have attacked three U-boats in two days.

Every additional aircraft that can be put into the sky over the Atlantic increases the chances. It can mean the salvation of tens of thousands of tons of precious shipping, the safe delivery to Britain of vast consignments of war stores and the safe transport of trained fighting men from the west.

Even to keep the U-boat below the surface can temporarily achieve these results by breaking its contact with a convoy.

To use a comparison with a land battle, each U-boat forced by an aircraft to crash dive is a few hundred yards of trenches won. Every U-boat destroyed is the reduction of a salient. Every convoy of shipping that passes unscathed to a British port is a local victory. And when the U-boats and the Focke-Wulfs are, one day, in full retreat from the waters between Britain and America, the war will have been won.

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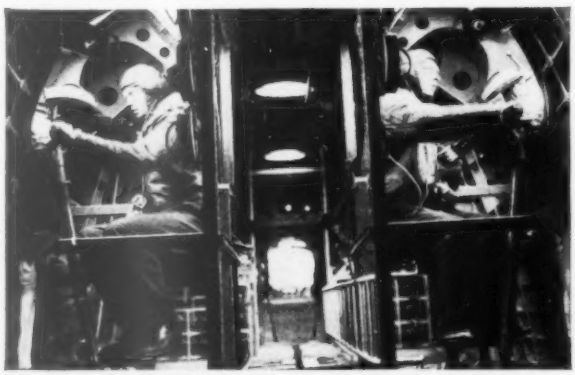


A vivid impression of the size of the "Sunderland" is given by this view of the two mid-fuselage gunners at their posts.

Infantry advance through a smoke screen. Above the smoke flies a Westland "Lysander" of Army Co-operation Command.

by Arthur Barratt

AIR MARSHAL SIR ARTHUR S. BARRATT, K.C.B., C.M.G., M.C., Air Officer Commanding-in-Chief, Army Co-operation Command. Born in 1891 in India and educated at Clifton and the Royal Military Academy, Woolwich, he joined the Royal Artillery in 1910, transferred to R.F.C. in 1914. Granted a permanent commission as squadron leader in the RAF in 1919. He commanded the No. 1 Indian Group in 1931-32, was senior staff officer of the RAF in India, 1932-34. He was commandant of the RAF Staff College, Andover, 1936-39, then A.O.C.-in-C. British Air Forces in France, 1940.

An army is no longer an army without aviation. Soldiers on the ground must have air support, for which the British devised this new Command.

ALL military commanders require two essential types of information. They need news of the enemy's disposition in the immediate presence of their troops, of the enemy's movements and of the presence of formations in the areas to the rear.

These are technically called tactical and strategical reconnaissance. To obtain this kind of information in the most accurate way, in the quickest possible time and by whatever air means are available, is one of the primary functions of Army Co-operation Command. Without this information, which only air reconnaissance can give, no commander-in-chief of a field force can plan his own movements and dispositions, and the work of Army Co-operation is therefore of the greatest importance in the modern development of war.

Reconnaissance is, however, only one of the forms in which air power can lend its potent aid to an army.

Other tasks such as spotting for artillery, close support, the attack of battlefield targets and other duties agreed upon by the commanders in the field are also undertaken by the Army Co-operation Force whose specialised squadrons may be reinforced by light bomber and fighter squadrons specially detailed for such purposes and trained in army air support.

Strategical support is afforded by other units of the Royal Air Force and when suitable opportunities occur all the available resources of the RAF may be used for the support of the Army.

In the Battle of France there were operating two separate entities under the control of an organisation known as BAAF (British Air Forces France), the whole being commanded by the writer. The first was *The Air Component*, containing a number of strategical and tactical reconnaissance squadrons protected by a small number of fighter squadrons. Both these formations were located as near to the British Army as was operationally possible. The second, situated in another part of France, placed so as to be able to strike in any direction, was the *Advanced Air Striking Force*, containing a number of light bomber squadrons, with the support of certain fighter units. The work of the Air Component was simply reconnaissance; the work of the Advanced Air Striking Force was bombing, which developed as the battle developed into tactical and close support bombing.

In the later months of 1939, and the early months of 1940, aircraft on tactical reconnaissance needed certain conditions in order to operate successfully. Speed of the fighter type of aircraft was not considered absolutely necessary for Army co-operation aircraft before the war and they were designed primarily to ensure that the pilot had a good all-round view. In strategical reconnaissance speed to enable aircraft to pene-

Called "Lizzies" in the RAF, "Lysanders" are admirably suited for Army Co-operation and reconnaissance work.

Britain, as well as Germany, has her big air transports. Here is a Bristol "Bombay" photographed in the Middle East.

trate more deeply into hostile country and to escape from hostile attack was of greater importance, as most of the reconnaissance was by camera and not visual. Accordingly, tactical reconnaissance squadrons were equipped with Westland *Lysander* aircraft, strategical squadrons with Bristol *Blenheims*.

In air reconnaissance the human eye, taking its pictures in seconds or split seconds cannot be trusted to record a factual picture. The camera is useful to supplement, check and confirm what a pilot or observer has seen or thinks he has seen. Behind the work of the camera is the trained eye of the photographic interpreter. In the months before the Battle of France began, when Belgium and Holland formed a neutral block between Northern France and Germany, tactical reconnaissance was not called for, but strategical reconnaissance, by means of photographic sorties over the whole length of the Siegfried Line, was carried out constantly and successfully. *Blenheims* flying from Metz made daily flights up the Rhine, north to Borkum and the North Sea and so back to England. The eyes of pilot and observer, the eyes of the cameras and the eyes of photographic interpreters collected in this way material of the very greatest military value.

On the early morning of May 10, 1940, these same *Blenheims*, flying hundreds of miles ahead of our advanced formations, discovered movements among the enemy's mechanised columns that were in reality the prelude to the most catastrophic crisis of the war. Behind them *Lysanders*, when contact was made with the enemy, made tenacious flights of reconnaissance over the enemy lines. Fighter aircraft, mainly Hawker *Hurricanes*, here and there a Gloster *Gladiator*, engaged great masses of enemy fighters. Light bombers, in an episode that has become historic, sacrificed themselves in the destruction of the Maestricht Bridge. And though the end of all this was the withdrawal of British troops from France, the campaign technically a military failure, a great and important principle had nevertheless been firmly established.

It had been made abundantly clear that the success or failure of an army in battle depended to a great extent on the degree of air superiority afforded to it. It was realised that with adequate fighter cover land forces have freedom of action, reconnaissance aircraft can work unmolested and even that most vulnerable of all aircraft, the dive-bomber, can take an effective part in the land battle. Without air superiority a military commander is faced with the persistent bombing of his armies, his reconnaissance aircraft are unable to operate and his own air forces are unable to support his troops on the battlefield.

The Battle of France brought this out perhaps more clearly than any other campaign, though Norway had foreshadowed it and Greece and Crete were stern reminders. In France, the Germans had many times the number of aircraft that were at the disposal of the British and French forces, with the result that the German generals were able to plan every phase of their swift advance with the sure knowledge that while their own troops would be comparatively immune from hostile air action, the German air force would be lightening their task by concentrated attacks on Allied reserves, lines of communication and centres of resistance.

The first reaction in some quarters was to attribute the German success to some miraculous co-operation between their air and land forces. Tales were told how squadrons of dive-bombers appeared from nowhere in a matter of minutes when the panzer divisions or German infantry met any opposition. We know now that this was not due to any magic quality in the German system of air communications (which are well understood to be of the simplest), but to the fact that these bombing attacks were planned many hours before, since it was known with certainty when plans were being made that troops or tanks would have reached such and such a defended

(*Continued on page* 254)

Soldiers unloading supplies from containers dropped by co-operation aircraft. Many outposts rely on planes for supplies.

A Bristol "Blenheim" used in the Burma campaign. Note the ubiquitous American "jeep" car in foreground.

EAST OF SUEZ

High mobility of air power is relied upon to defend the long coastline of India. Indian youth prove splendid pilot material.

A group of pilots of the Indian Air Force. The majority are Bengalis. Note variety of head-gear includes turban.

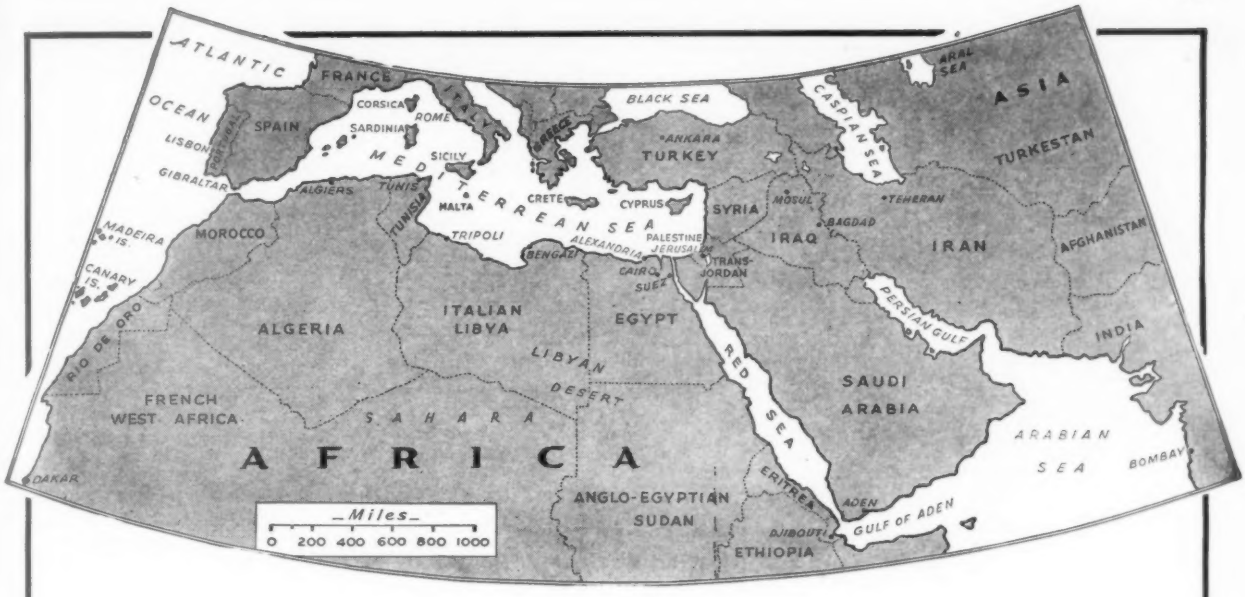
A.C.M. Sir Richard Peirse

AFTER the failure of their first attack on Ceylon, the Japanese advance towards India appears for the moment halted; but in view of their considerable conquests it must be assumed that this is a natural pause. Nevertheless, it has provided valuable time for strengthening India's defences. Protection of the long coastline from sea invasion presents considerable difficulties; but given adequate maintenance facilities air power is highly mobile and can be concentrated rapidly at any point of danger. Directing the air forces in India is Air Chief Marshal Sir Richard Peirse, K.C.B., D.S.O., A.F.C., Air Officer Commanding-in-Chief, Air Forces in India, former Commander-in-Chief, Bomber Command.

Sir Richard has held a number of important posts, including those of Deputy Director of Operations and Intelligence at the Air Ministry and of Air Officer Commanding British Forces in

(*Continued on page* 270)

All useable parts of this Bristol "Blenheim," forced down in Irrawaddy River, will be salvaged by RAF crew.



THE MIDDLE EAST

The eyes of the world are turned on this war theatre. In it, the RAF has been—and is—faced with some of the toughest operations problems known.

Bombing-up an American Martin "Maryland" for a raid. In recent operations "Marylands" shot down five Germans in five days.

Latest American fighter in Middle East is Curtiss "Kittyhawk." As a light bomber it is called "Kittybomber."

THE MIDDLE EAST by Arthur Tedder

AIR CHIEF MARSHAL SIR ARTHUR WILLIAM TEDDER, K.C.B., Air Officer Commanding-in-Chief, Royal Air Force, Middle East is a 52-year-old Scotsman. A graduate of Magdalene College, Cambridge, he entered the Dorset Regiment in 1913, transferred to the R.F.C. in 1916 and served in France and the Middle East. He commanded No. 207 Squadron at Constantinople, 1922-23. He was on the directing staff of the RAF Staff College from 1929-31, was Director of Training, 1934-36 and Director-General of Research and Development from 1938-40. From 1940 to 1941 he was Deputy A.O.C.-in-C., Middle East, after which he took over the command.

This aerial photograph records groups of Italian prisoners captured when Bardia fell to the Allied forces.

WHERE is this territory, the apparent counterpart of that great American belt the Middle West, which has become so well-known and yet is not to be found on any ordinary map?

Before the war much of the Middle East was covered by a Royal Air Force Command with headquarters at Cairo and units stationed in Egypt, Sudan and Palestine. Adjacent to it were the sister Commands of Iraq, Aden and Malta.

On the outbreak of war the Middle East Command was extended to embrace those adjoining Commands. Later it had to operate in Abyssinia, Libya, in Greece, Albania and Crete, in Iraq and in Iran, and finally in Syria.

The area in which the Command now operates may roughly be likened to a number of broad spokes of a wheel the centre of which is Cairo, the spokes radiating to the four points of the compass. The eastern area embraces the Western Desert and Libya; to the south, control is exercised over the whole of Egypt and the Sudan, Abyssinia, British Somaliland and Kenya, an area extending to the centre of Africa; on the east and northeast the control ranges through Iraq and Iran to the borders of India, while to the north there is the shorter spoke embracing Palestine and Syria and including Malta and Cyprus. To the northeast the Command adjoins Soviet territory, and in Syria it marches with Turkey.—Ed.

* * *

The War in the Middle East has been a series of battles for aerodromes. As the armies moved back and forth across Cyrenaica it was landing grounds for which they fought, for landing grounds spell air superiority—with all that this means. So it was in the Western Desert, so in East Africa, Syria, Iraq and Persia, and particularly so in Greece and Crete. The significance of Malta has always been that its aerodromes command Sicily, Italy, Tripoli and the enemy supply routes across the Mediterranean.

A war for aerodromes. Hold them and you advance. Lose them and you retreat, whether on land or on the sea.

The squadrons of the RAF which were stationed in the Middle East were there in the first place for one clear reason—to protect Egypt and our lines of supply through the Suez Canal and the Red Sea. This was scarcely a problem unless Italy entered the war, nor was it an urgent problem so long as there were a Western Front in Europe, French armies in Tunisia, Syria and Somaliland, and reasonably safe communications through the Mediterranean. Consequently, as there was pressing need for aircraft in other theatres of war, the air strength in the Middle East was then numerically puny and the aircraft largely obsolescent or obsolete.

When war came eastwards, however, it was in circumstances

An American Martin "Maryland" at work. Its bombs are bursting on an Axis encampment near El Adem, in the Libyan desert.

RAF bombers caught these Axis warplanes on the airport at Derna. Among types recognizable are Junkers, Heinkels, Bredas.

unpredictably disastrous. As Italy declared war the Western Front collapsed, and with it not only the menace to Italy from Tunisia and East Africa but our Syrian bulwark as well.

The Air Officer Commanding-in-Chief, Middle East, could balance his forces against those of his opponents in this manner:

For the defence of Egypt, even if he brought his aircraft in from Palestine, he had approximately 40 *Gladiator* fighters, 70 *Blenheim* bombers, 24 other bombers, 24 Army co-operating *Lysanders*, and 10 *Sunderland* flying boats. All except the *Blenheims* and the specialised *Lysanders* and *Sunderlands* could fairly be called obsolescent.

For the attack on Egypt from Libya the Italians had at least 200 modern bombers and 200 modern fighters. Looking south the situation was no better. The Italians held in East Africa a total of 110 bombers, and 60 fighters. All we could muster against that were about 85 *Wellesleys* (single-engined bombers) and *Blenheims*, with a few *Gladiators*, *Battles* and Junkers Ju-86's.

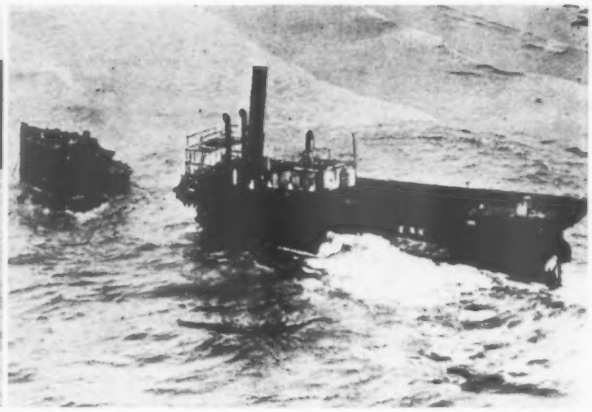
Besides this the Italian Air Force in Libya could be reinforced easily from Italy not only with its own aircraft and crews but with those of the Luftwaffe, while long range bombers as reinforcement could be flown by night from Libya across the Sudan to East Africa. The position worsened in August, 1940, when the loss of British Somaliland gave to the Italians the aerodromes at Berbera and released their aircraft for use against Sudan and Kenya.

Faced with great numerical inferiority on every front, the RAF took the only possible course—the offensive. British aircraft in the Middle East have held to that ever since. There have been occasions when the land forces have been compelled to stand on the defensive, but even during those periods the Air Force has kept to the attack.

This began in the first few months both in the Western

South African Air Force pilots leave their Douglas "Boston III" after a raid on Axis positions. "Boston" is well-liked in desert.

Allied bombers did efficient work on the harbour at Bardia. This is how it looked when British forces entered the city.



Another enemy vessel shows the mark of Allied bombers. A bomb hit directly ahead of the bridge cut the ship in half.

Desert and in East Africa. Bombers based on Sudan and Aden repeatedly raided the Eritrean ports and the Italian petrol and supply dumps. One impressive sortie was a long distance raid on Addis Ababa by obsolescent *Wellesleys* from Aden. Although the weather was bad and the country mountainous the bombers hit four Italian hangars, destroyed five of their aircraft, started a large petrol fire, and in consequence drew off forces of Italian fighters from all fronts to protect the capital.

In the Western Desert the RAF force available—three squadrons of *Blenheims*, one of *Gladiators*, and one of *Lysanders*—was established near Mersa Matruh, and it struck with such power as it possessed at the Italian aerodromes in Libya within a few hours of Italy's declaration of war. Although they were the aggressors, the Italians were taken completely by surprise and had not even properly dispersed their aircraft and petrol supplies.

Our blow was not heavy, but it was swift and it told. We had the initiative, and we kept it. Tobruk, Derna, Bengazi, and the big enemy encampments were repeatedly attacked—even when the Italian ground forces, after three months preparation, moved forward to Sidi Barrani and hailed as a major victory the occupation of ground from which General Wavell had purposely withdrawn.

The enemy moved forward, but the RAF continually ground strafed his lines of communication and his aerodromes, not only destroying large quantities of his supplies, transport and aircraft on the ground, but also forcing him to put up constant patrols of his own fighters over the roads and the landing grounds, in this way countering his numerical superiority in the air.

By that time, of course, we had been somewhat reinforced. By October the position looked much more promising. Then Italy declared war on Greece, and the decision was rightly taken to send aircraft to the help of our new Allies.

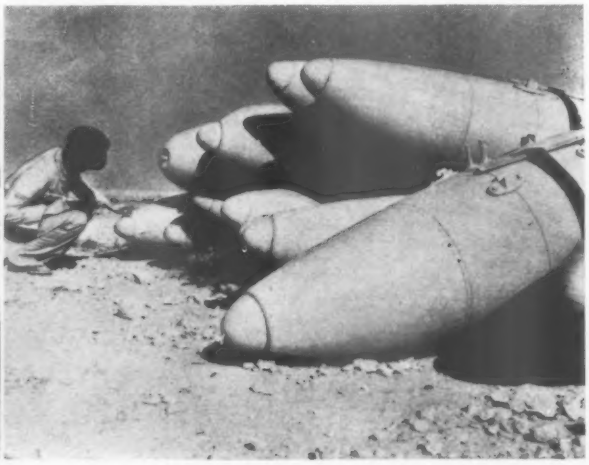
This meant depleting the forces in the Western Desert, though the time was approaching when we should launch an offensive of our own in that theatre. Reinforcement of aircraft was started again, and by the time of the offensive we had in the Western Desert the first two squadrons of *Hurricanes*, four of *Lysanders*, two of *Gladiators*, and five of *Blenheims*. Two squadrons of *Wellingtons* and a few *Bombays* were available for night bombing, and the risk was taken of moving forward the fighter defence squadrons from Alexandria and the Sudan. Even so, the Italian fighter force still outnumbered our own by four to one.

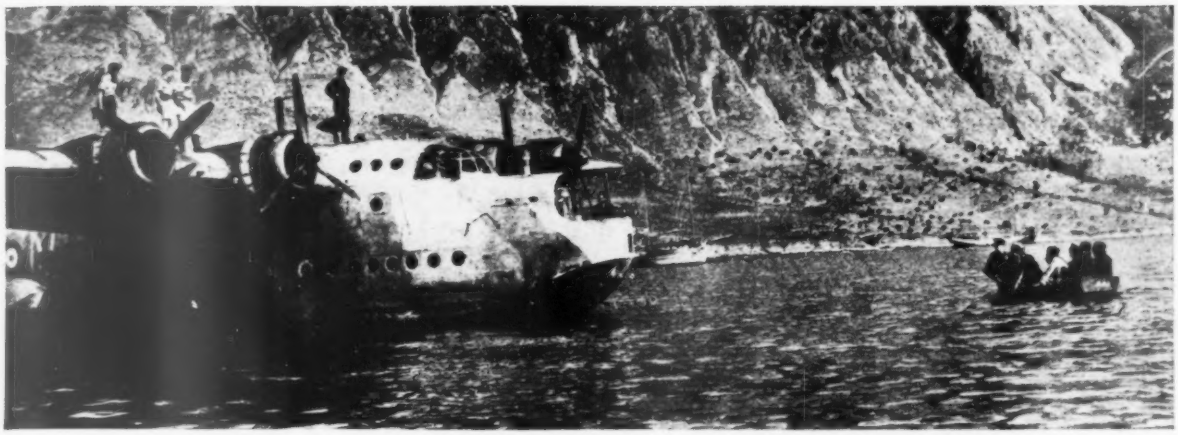
In the early days of December, 1940, the RAF and the Navy prepared the way for the Army assault. The Navy bombarded Sidi Barrani and Maktilla; the RAF delivered heavy attacks on the Italian camps and on Benina aerodrome near Benghazi. All the time, both before and during the Army advance, the ground strafing and bombing of enemy aircraft on the landing grounds, of their transport on the roads and of their ships in the harbours continued.

When we had advanced sufficiently we counted some 1100 enemy aircraft out of action at the various landing grounds. The roads were littered with broken and crippled transport, and 35 ships were found sunk in the harbours at Barin, Tobruk, Gazala, Derna and Bengazi, all accounted for by bombing. The success of the first British Libyan campaign is already history. The advance began on December 9, with a very limited objective. We intended to advance as far as Buq Buq. In fact the campaign proceeded rapidly to a destruction of

Bombs for Allied aircraft are cached in huge dumps in the desert. RAF officers are selecting some for a bombing raid.

Not bombs, but auxiliary fuel tanks for Nazi aircraft, abandoned, along with great quantities of supplies, at a Libyan base.





Short "Sunderland" flying boats played a magnificent part in the withdrawal from Greece. Here are RAF personnel being rowed out to one of the big boats. Note how gun turret has been retracted.

the whole Italian army in 62 days, the capture of 133,295 prisoners, 1,300 guns, and vast amounts of war material, and a British occupation of the whole of Cyrenaica.

The work of the Air Force in this campaign was diverse. Before each Army assault the bombers attacked in turn Sidi Barrani, Bardia—the "Bastion of Fascism"—Tobruk, Derna and Bengazi; but these bombing raids would scarcely have been possible had not our fighters pinned down the Italian fighter force and kept it continually on the defensive. The strafing of the aerodromes and the roads did that, and on their homeward journeys our fighters often encountered the unescorted Italian bombers which were trying to give support to their troops. We shot down 74 enemy aircraft during the first week of the advance alone.

Until the Army advanced beyond Bardia our air superiority over the enemy had been secured and maintained by air action alone. To the westward of Bardia and Sollum there runs for over 100 miles a vast flat plain, admirable for aerodromes. Beyond that, to the west of Derna, there stretches some 150 miles of hilly country. Between Derna and Bengazi were only two aerodromes fit for modern aircraft.

Between Derna and Sollum were based the great majority of the Italian air forces, with their main base at El Adem. As our mobile land forces swept round over the great plateau the Italians had to evacuate one after another of their easterly aerodromes, only to be attacked by our fighters and bombers again and again on the ground at their westerly aerodromes at Gazala, Timimi and Derna. Part of our squadrons moved up quickly behind our advanced land forces. For this battle the Italian air force was virtually "out," and our fighters were free to harry the retreating Italian columns into the disorder and rout which culminated in General O'Connor's brilliant thrust across 150 miles of desert and his victory at Beda Fomm, south of Benghazi.

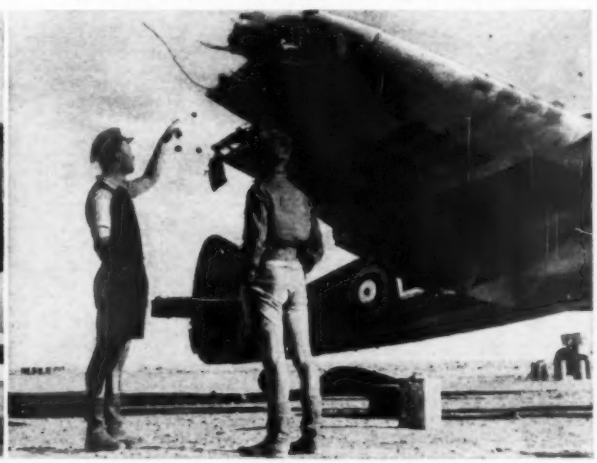
Could we then have advanced on Tripoli? At the time this became a world debating point. Even if there had been no other fronts to consider, the supply problems had become acute in an advance aimed at Buq Buq which had reached El Agheila. The German Air Force had now come into action and was doing its best to make Benghazi untenable as a supply point. The motor transport available, over some of the worst desert tracks imaginable, had already been subjected to stringent wear.

At this point it is necessary to step back a little. Italy declared war on Greece on October 28th, 1941, before the British offensive in Libya. The British Government decided that whatever possible RAF support could be given to the Greeks must be given. Accordingly, two squadrons of *Blenheim* bombers, one of *Blenheim* fighters and one of *Gladiators* were despatched to that country, dangerously weakening the Western Desert force even before our campaign began. Some *Wellington* bombers were also sent over from Egypt to operate against the enemy's disembarkation ports during moonlight nights.

The position then was that the Italians had made some small advances from Albania on to Greek territory but were being held. The small valiant Greek Air Force, sadly equipped, had flown itself almost to a standstill in giving close support to the Army. The RAF force of bombers concentrated on hitting the enemy's lines of communication, with the result that by the

These are Rhodesian fighter pilots serving in the Middle East. Plane is a "Hurricane." Pilot at right holds mascot.

While ground-strafing, this "Beaufighter" hit a telegraph pole, lost three feet of wing, flew 400 miles to its base.



Troop carriers play an important part in desert warfare. This is a Bristol "Bombay" about to land with its cargo of soldiers.

end of November the Greeks were able to start a counter offensive. At first the chief difficulty in Greece was that of aerodromes suitable for modern aircraft. There were not even any good sites for them. On the Larissa plain the rains had already started, and the ground was flooded.

So the bombers had to be placed on aerodromes near Athens and the fighters made shift with whatever they could find near the front lines. By the end of the year, in spite of these difficulties, Valona and Durazzo, the two Albanian ports, were being thoroughly bombed; the fighters had established partial air superiority against great numerical odds; and the Greek Army had not only thrown the Italians out of Greece but had started to invade Albania. Then with the new year came the snow. It did not ground the RAF squadrons but it forced them to fly over mountainous country in conditions of extreme difficulty and danger. The Italians had concentrated large forces of antiaircraft guns at the main targets and every raid that the *Blenheims* undertook meant first a long difficult flight to the target, then a barrage through which few went unscathed, and at last an even more difficult flight home.

This is a "Hurricane" pilot at Malta, returning to his base after fighting off one of the Axis attacks on the tiny island.

The ground situation was largely stabilised by the weather, but the Germans were gradually massing in Roumania. By February, the Libyan campaign was nearly over and Cyrenaica was clearly ours. We were committed to Greece; so it was decided, in spite of the obvious risk, to start transferring more squadrons from the Western Desert to that country. The Greek Army had already taken Tepelene but the weather prevented them from throwing the Italians into the Adriatic before the German attack. This was in spite of the fact that the RAF changed its policy in Albania in order to give much closer support to the ground forces.

The prestige of the RAF never stood higher in the minds of the Greeks than at that time. The first *Hurricanes* from the Western Desert appeared over Athens in February. On February 20, they made their first sortie over the lines and shot down four enemy aircraft. Eight days later, in full view of the Greek forces in Albania, they fought out the greatest air battle on that front. Ten *Hurricanes* and 18 Gloster *Gladiators* met a large force of enemy aircraft over the Greek lines. They shot down 27 of them with no loss to themselves. The Greeks were ecstatic.

March was an indeterminate month. During that time the Italians counter-attacked without much success. The Greeks accepted at last the offer of a British Expeditionary Force which, with further RAF reinforcements, was drawn from the Western Desert—thus enabling the German Army then in Tripolitania to throw over our skeleton holding-forces out of Cyrenaica.

The Italian Naval force which met the Mediterranean Fleet was smashed at Cape Matapan. Six Fairey *Swordfish* Naval aircraft arrived in Greece and wrought heavy damage to Italian shipping in Valona and Durazzo harbours. The Germans had subjugated Roumania and crossed in force into Bulgaria. Yugoslavia, whose Goverment had been preparing to capitulate, revolted and prepared to fight.

On April 6, Germany declared war against Greece and Yugoslavia. The RAF had been reinforced—but to what did it amount, and what opposition had it to face? Supporting the Greeks in Albania there were one squadron of bombers and one of *Gladiator* fighters. On the landing grounds of the Larissa Plain, still soft after the winter rains, there were two bomber squadrons and one squadron of *Hurricanes*. Their task was to support the Anglo-Greek forces which were facing the German advance. Stationed near to Athens were another bomber squadron, and a fighter squadron rearing with *Hurricanes*. In all Greece the RAF had a total of about 80 serviceable aircraft.

From Bulgaria and Roumania the German armies were advancing with the support of some 800 aircraft. The Italians had 160 based in Albania; and a further 150 based in Italy but operating over Albania and Greece. The odds against us, in numbers alone, were well over 10 to one.

Our aerodromes were only just drying out from the rains, and were far from fully serviceable. Communications between them were of the sketchiest kind. On April 6, the Germans started to come west through the Struma Valley to attack Mount Beles and the Rupel Pass. Twelve *Hurricanes* flew out to meet them. They met 20 Messerschmitt Me-109's, and shot down five of them without loss to themselves. The first round was ours.

That night the *Blenheims*, with some *Wellingtons*, bombed successfully behind the German lines; and the following day, in spite of terrible weather, some of our bombers got through to the bottle neck at Strumitsa and did fierce damage to the German transport which was pinned there by the mountains and the marshes. It was impossible to give air support to the Greek forces cut off in the Salonika area. Within a few days our squadrons were fighting a delaying action. The

strength against us was overwhelming, and all we could hope to do was to hold up the German advance.

At first the German Air Force had mainly been occupied with giving close support to the ground troops, and our *Hurricanes*, patrolling over those areas, had shot down many enemy aircraft. Too many, it appeared, for the Germans to suffer; for on April 15, they switched their air power against our few forward aerodromes.

They ground strafed the *Hurricanes'* aerodromes at Larissa just as three of our fighters were taking off. Two of the *Hurricanes* were shot down; the third shot down a Messerschmitt Me-109. In the meantime, in the north the Yugoslavs had collapsed, and some of our bombers were engaged in trying to stem the German land forces there. In the east the Anglo-Greek forces were withdrawing, and April 15 saw the complete evacuation of the Larissa Plain, together with all our aerodromes and landing grounds on it, which were by then just beginning to recover from the winter weather.

The squadrons moved to the only remaining aerodromes, which were those round Athens and two farther south at Argos. In Albania, after the collapse of the Yugoslavs, the German forces compelled the Greeks, who had fought so hard and so well, to surrender. The two RAF squadrons were successfully withdrawn, but very soon it was clear that the Greek campaign was lost. It could never have been otherwise, against such odds. The RAF were left with the task of doing their best to cover the evacuation, for the whole weight of the Luftwaffe was turned on the Athens area.

All our bombing targets were chosen at points just behind the German lines where they had great concentrations of transport, and uncounted damage was done. To give only one instance, the *Wellingtons* broke the bridge at Varda, the very hinge of the German lines of advance.

On April 19 our fighters sang a gallant swansong. There were 15 *Hurricanes* left. The Germans directed a force of about 100 dive bombers and fighters on to Athens and its surroundings. The 15 *Hurricanes*, piloted by men who had seen five months of continuous fighting abainst heavy odds, went up to engage them. They shot down 22 enemy aircraft confirmed and a further 8 probables. Five of the *Hurricanes* were lost. It was a magnificent demonstration of the comparative abilities of the German airmen and our own. But the loss of 33 per cent crippled the *Hurricanes*. The remaining 10 were sent to Argos to cover the final evacuation of the British troops, but most of them were destroyed on the ground and the remainder were evacuated to Crete.

(*Continued on page* 262)

Tough fighters, these Australians. The squadron of "Tomahawks" at top is an Aussie unit in Syria. Some of its pilots are in the inset. This "Tomahawk" is the same as the U. S. P-40.

These are bomber crews, standing in front of one of their "Wellington" twin-engined bombers at a desert RAF air base.

MALTA, G.C.

The George Cross

If any piece of ground could be called unflinching, it would be Malta. The tiny island has withstood appalling hardships.

SIREN ISLAND, they call it. But this is a modern legend. These sirens do not sing, they howl. A dozen times in the day you'll hear them; and then again in the night. For this is Malta G.C., Island of the George Cross, highest token of civilian valour; 100 square miles of sandstone rock now famous as the most heavily-raided place in the world.

But though Malta has won fame in defence, there is another story which the historians will tell. Malta has been mercilessly attacked because of her power to strike at the heart of the enemy—and the true measure of the Luftwaffe's failure is that they have not robbed her of this power.

Seventy miles south of Sicily and 200 east of Tunis, Malta is of the highest strategic importance in a Mediterranean war. From aerodromes on the island, RAF bombers can operate against the nerve-centres of the Italian production and supply systems. Moreover, the presence of a hostile base at a focal point of the Italian convoy routes from Messina to Tripoli creates awkward danger zones for Axis shipping.

From the day of Italy's entry into the war, British warships and submarines, naval torpedo bombers, and RAF *Wellingtons* have intercepted and destroyed enemy convoys crossing from Italian ports to Libya. In the summer of 1941, when both sides were preparing for a Western Desert offensive, these forces were sinking about 50 per cent of the enemy shipping using this route. Ansaldo, the Italian spokesman, has described Malta as a "colossal and unsinkable aircraft carrier, almost within sight of the Italian coast."

When, early in December last year, Field Marshal Rommel was ordered by Hitler to plan a Libyan counter-offensive, he insisted that the Luftwaffe must ensure that his convoys got through. So the German Air Force, which had already hammered at Malta the previous winter—having, among other failures, tried in vain to sink the aircraft carrier *Illustrious*—went back to Sicily for a second and more determined effort.

Hitler sent Field Marshal Kesselring to command these squadrons of Junkers Ju-88 bombers, Ju-87 dive-bombers, and Messerschmitt Me-109 fighters. His orders were to remove the "Malta menace." The fact that Kesselring was chosen for the job was proof of the importance the German High Command attached to the removal of this "thorn in the side of Axis strategy," for the field marshal had commanded "Luftflotte 2" during the invasion of Western Europe and the Battle of Britain.

On November 25, 1941, General Sir William Dobbie, commander in chief, gave a survey of the situation. Malta, he said, had been raided on 972 occasions; 344 persons had been killed and 685 seriously injured; houses utterly destroyed or hopelessly damaged totalled 2,552. Cities in Britain had suffered worse things. All essential supplies were being maintained. Six days later, after 27 months of war, Malta clocked up its thousandth air-raid warning. *Now after a further seven months the total is close to 3,000.*

Gen. Sir William Dobbie (left), former Governor of Malta, is shown with Air Marshal Sir Arthur Tedder, A.O.C. in C. Middle East.

These figures give a measure of the intensity of Kesselring's attack. Slowly its strength mounted. During Christmas week the German air force lost five dive-bombers and two fighters, in addition to 10 Junkers Ju-88's and five Messerschmitt Me-109's so severely damaged that few can have regained their bases. The weight of the assault grew. There were 258 alerts in January, and though in February there were 25 fewer, no less than 153 developed into serious raids, 97 during the night and 56 during daylight hours. By March 10 it was plain that an all-out attack was developing. "The Luftwaffe have been making non-stop efforts to neutralise the

(*Continued on page* 230)

Every raid on Malta by German and Italian bombers leaves new piles of rubble. But enemy losses have run high and the spirit of the people is unbroken.

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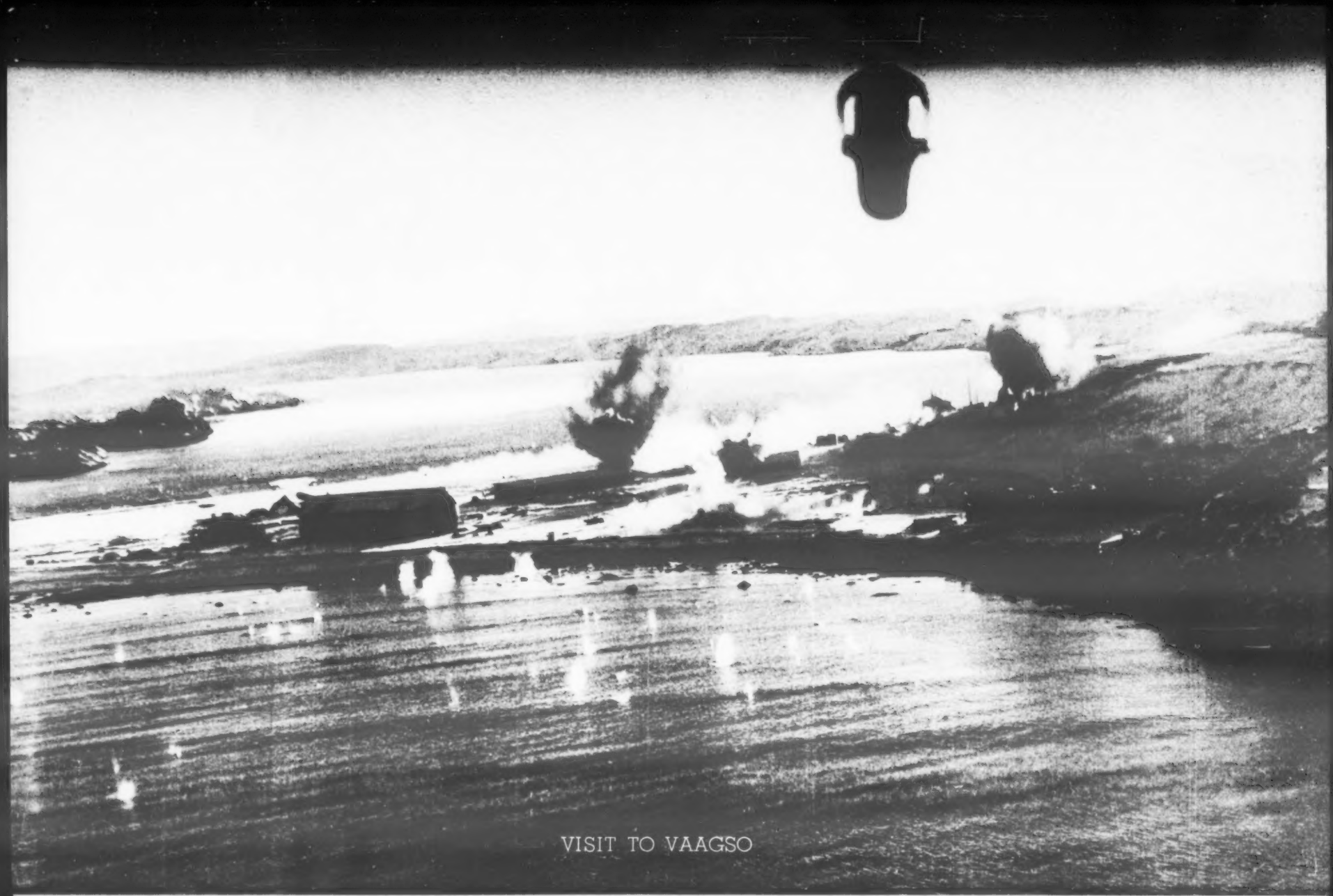
Salon Section

The British Air Ministry presents on the following pages an especially selected series of outstanding photographs of various Royal Air Force commands in action.

(For Background Data see page 276)

KNIGHT OF THE AIR

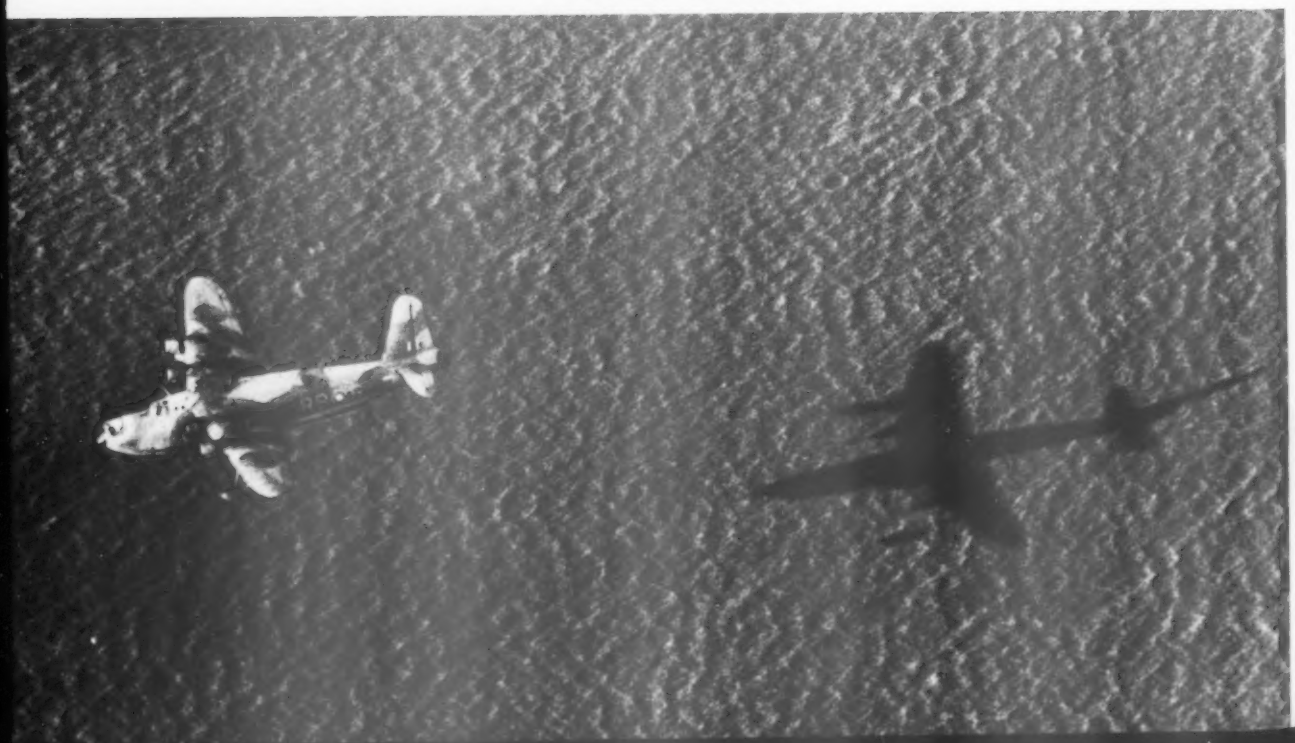


VISIT TO VAAGSO

TIN FISH

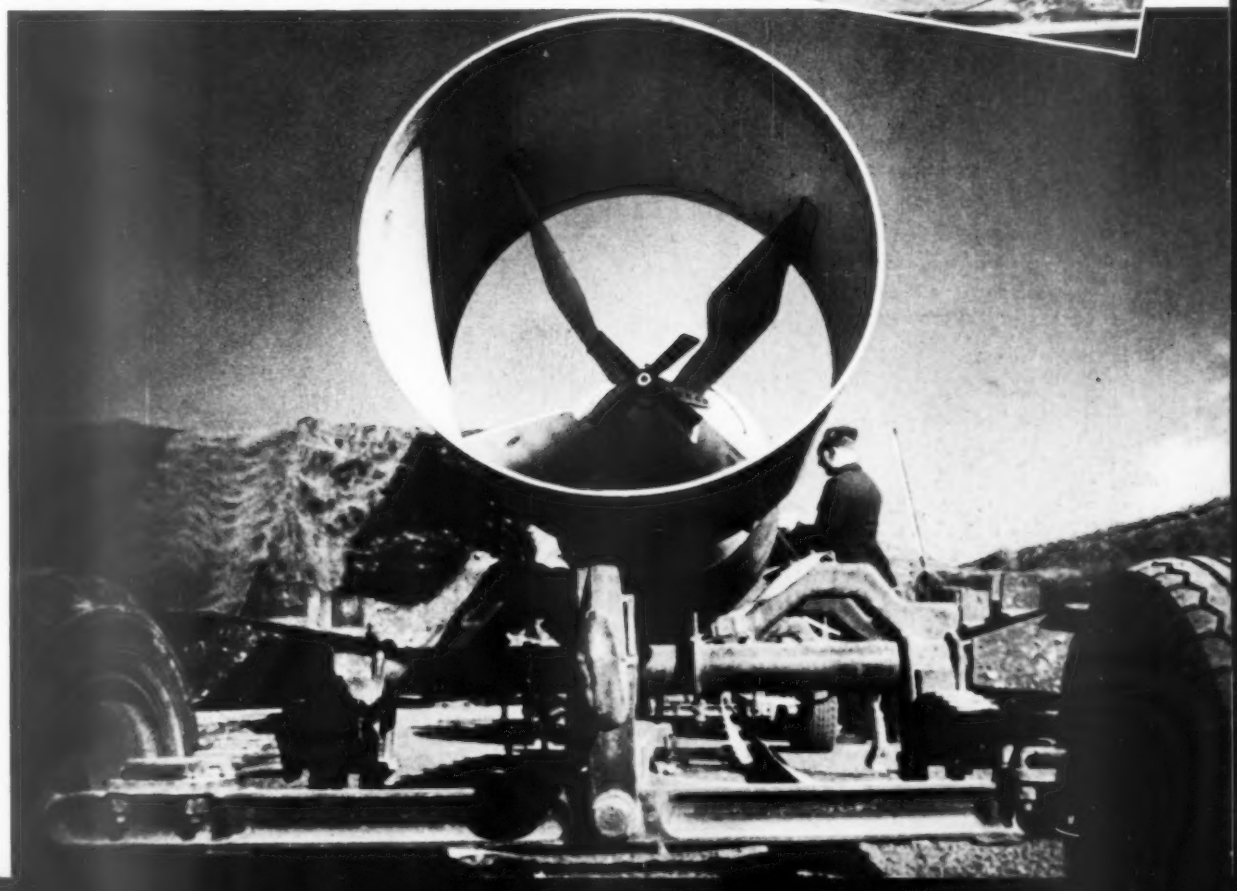
ON GUARD

HUNTER'S SHADOW



GERMANY BOUND

BUNDLE FOR BERLIN



STING IN THE TAIL

STORM BREWING

ICELAND PATROL

CEYLON

by J. H. D'Albiac Air Vice Marshal

AIR VICE MARSHAL J. H. D'ALBIAC, C.B., D.S.O., Air Officer Commanding, Ceylon, has served in all three British services, the Navy, Army and Air Force. In 1914, on the outbreak of World War I, he enlisted in the Middlesex Regiment. Air Vice Marshal D'Albiac was later granted a commission in the Royal Marine Artillery and then was assigned to the Royal Naval Air Service. He was subsequently given a permanent commission in the RAF.

ISLANDS have played, and continue to play, a vitally important part in this war.

In Europe, in the Middle East, in the Pacific, in practically every theater of operations islands have taken on an importance bearing often no relation to their size. The Battle of Britain was a battle for an island; Malta has shown how a few square miles of rock can defy an aggressor. Other islands have fallen—Crete and the Netherlands East Indies, for example. Prompt and firm action gave the Allies control of the valuable Madagascar naval base of Diego Suarez.

Japan's first treacherous blow was directed against America's chain of island bases in the Pacific, but with Japan joining the other Axis powers and spreading war to the Far East, the island of Ceylon, hitherto wrapped in comparative obscurity, took on a new significance.

Royal Air Force flying boats and naval craft combing the Indian Ocean in search of infrequent commerce raiders used the island as a base. For convoys bound for Indian ports, or steaming eastward to the dazzling deception of Singapore, Colombo was a pleasant port of call. Trincomalee, a magnificent naval anchorage, was practically deserted.

But now the picture of Ceylon underwent rapid and radical change.

Since the fall of Singapore the island's air garrison has been considerably strengthened both in aircraft and technical equipment. From other fields of war have come experienced pilots to fly the *Hurricanes* giving fighter cover to the harbours of Trincomalee and Colombo. The eastern approaches are swept in long patrols by flying boats using bases surveyed and established long before the war; and any invasion fleet which may emerge westwards through the water-gates of Japan's "wall" will find a not inconsiderable striking force prepared for its reception.

"Buttoned-up" and ready for action, Ceylon is now a self-contained stronghold.

At the end of March it became clear, following Japanese naval movements in the Indian Ocean and the Bay of Bengal, that an air attack on Ceylon was imminent. The probability was that this attack would develop from the southeast, and reconnaissance patrols by *Catalina* flying boats were organised to meet this contingency.

With the exception that a Japanese submarine was sighted and attacked south of the island, the patrols produced negative results for a few days. However, shortly after four o'clock on the afternoon of April 4, Squadron Leader Birchall of the Royal Canadian Air Force, captain of a *Catalina*, reported sighting a considerable enemy force some 350 miles to the south of Ceylon. Nothing further was heard from his flying boat, and the assumption is that it was shot down. Its gallant captain had just arrived on the island—indeed, he was so new to his station that he had not met any of his fellow officers before taking-off on his last patrol. Much is owed by Ceylon and the RAF to him and to his vigilant crew.

Air Vice Marshal D'Albiac, while serving in Palestine prior to becoming A.O.C.-Ceylon, chats with Capt. James Roosevelt during the visit of the President's son as an air observer.

As soon as the sighting report was received a second *Catalina* was detailed to shadow the enemy forces, and just before midnight this second aircraft established contact with its quarry about 270 miles south of the island. The enemy was later lost in the darkness. It was clear, however, that he was making towards Colombo.

During the night the Command ashore made ready to meet and break the attack that seemed certain to develop. From calculations, it was estimated that the enemy would be over the Colombo area at about 7:30 a.m. The searching *Catalinas* established contact with the enemy again just before dawn and reported the position of the Japanese fleet as about 180 miles southeast of Colombo. On the island defence plans had been completed. Pilots of the *Hurricane* squadrons, eager for fresh action after pasting Germans and Italians in the Western Desert, were impatient for their first encounter with the new enemy. After an all-night vigil the Operations Staff waited at its battery of telephones ready to put the carefully prepared machinery into motion.

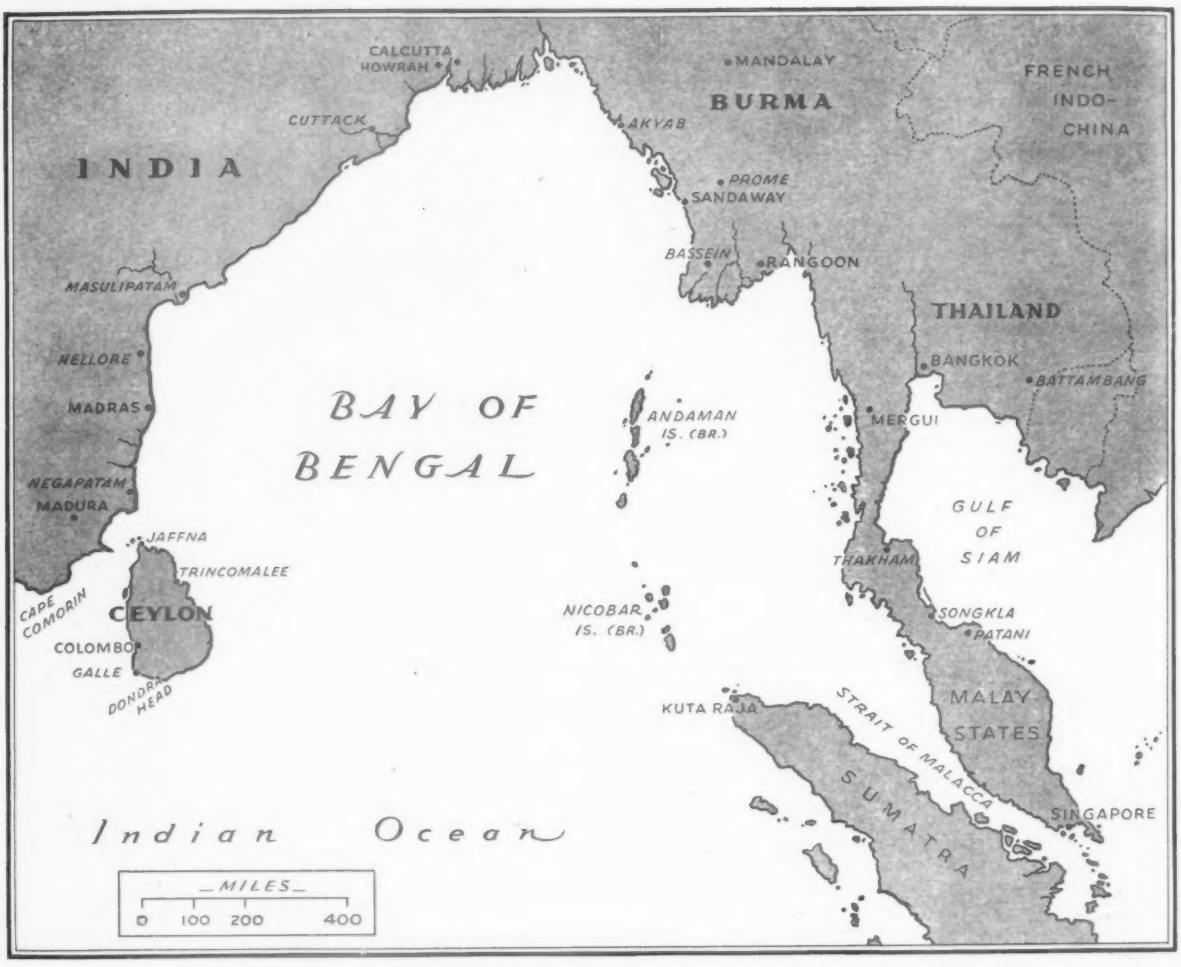
There was tense expectancy for the opening of what might well prove to be a decisive engagement for Ceylon.

The Command's calculations were correct and, within a few minutes of the estimated time of the attack opening, the first Japanese aircraft were heard approaching. There were two attacks—one on the harbour district and the other on the nearby Ratmalana aerodrome. The weather was overcast and low black clouds shrouded the city. As they approached, the Japanese aircraft were visible coming down the coast, but a mile or so before they reached Colombo the clouds intervened.

But the *Hurricanes* were ready; so were the ground defences. The air war came to Ceylon as the opposing fighters streaked in and out of clouds in a grim hide-and-seek, and the black silhouettes of dive bombers swept steeply down as they attempted to find their targets. That morning there were about 50 Japanese aircraft over Colombo and about the same number above Ratmalana.

When, slowly, the battle drifted out over the sea, its outcome was still uncertain to those on the ground, yet even then it was becoming clearer every moment to the Operations Staff that the enemy was badly disorganised. The result of the engagement became apparent as the *Hurricane* pilots made their reports when they came in to re-fuel and re-arm.

Finally the fact emerged that the Japanese had lost 30 aircraft destroyed or probably destroyed, with a further 25 damaged—a gratifying result and one which, for the *Hurricanes*



The military importance of Ceylon as a bastion against an enemy move westward or as a base for launching an Allied attack eastward is revealed by a study of the island's location in Indian Ocean.

at least, laid the bogey of the Japanese Navy *Zero* fighter.

Even so, the enemy still had plenty of aircraft left aboard their carriers, and despite the severity of their mauling at Colombo they tried their luck at Trincomalee on the morning of April 9.

A few minutes after seven o'clock they were sighted by a *Catalina*. As this aircraft's sighting report terminated suddenly before it was completed it appeared obvious that this *Catalina*, like its predecessor five days earlier, had been shot down.

At about the same time as the attack on Colombo had opened, six enemy aircraft appeared over Trincomalee and the nearby aerodrome of China Bay. A small formation of *Hurricanes* had met the attackers out at sea, but it was too small a force to hold off the Japanese. Nevertheless, when the enemy reached the vicinity of their targets, they must have been highly disconcerted to find their objectives further protected by a newly-raised balloon barrage. One Japanese pilot, overbold in his attack, came to grief after fouling a balloon cable.

In the meantime, larger formations of British fighters had gone into action, and these, with great zest, proceeded to make hay of the Japanese. At the same time, *Blenheims* were sent to bomb the enemy's carriers. They encountered strong opposition from the air and concentrated fire from the Japanese fleet, but they pressed home their attack with great resolution.

This second attack was more expensive to the Japanese than was the first. To the keen satisfaction of the RAF and the ground defences, some 37 enemy aircraft were destroyed or probably destroyed, and two others were listed as damaged.

In the two raids, in each of which about 100 Japanese aircraft participated, the enemy's total losses were one-third of his force destroyed or probably destroyed and a further eighth damaged. It was a fine victory for the island defences; is it too much to ask whether it was not against the coasts of Ceylon that Japan's westward progress was halted? Certainly it is significant that the enemy made no immediate effort against Ceylon after his first two reverses.

After this first taste of action the RAF organisation made considerable progress, heartened and encouraged by the experience gained in April. Reinforcements have included a squadron manned by Royal Canadian Air Force personnel, and all branches are in fine fettle and ready for any renewed call to action.

What may be the probable role of Ceylon in the future course of operations? That question is not difficult to answer. Several "blueprints" of Japanese expansion have been issued during the past decade, and according to these the first phase is limited to territories now in process of "pacification." A pause is envisaged before the second stage, which according to the Japanese plan involves the conquest of Australia, India and Ceylon. The mere fact that our Far Eastern Enemy has so far worked to blueprint does not mean that, if he considers the opportunity ripe, the pause between the two stages will be any more than nominal. It appears clear that Japan's ultimate —perhaps not very remote—intention is to conquer and occupy Ceylon.

There is a second threat to the island, and one which must be considered more immediate. This is related to the phase of war in which Anglo-Saxon resurgence into the Far East

(*Continued on page 275*)

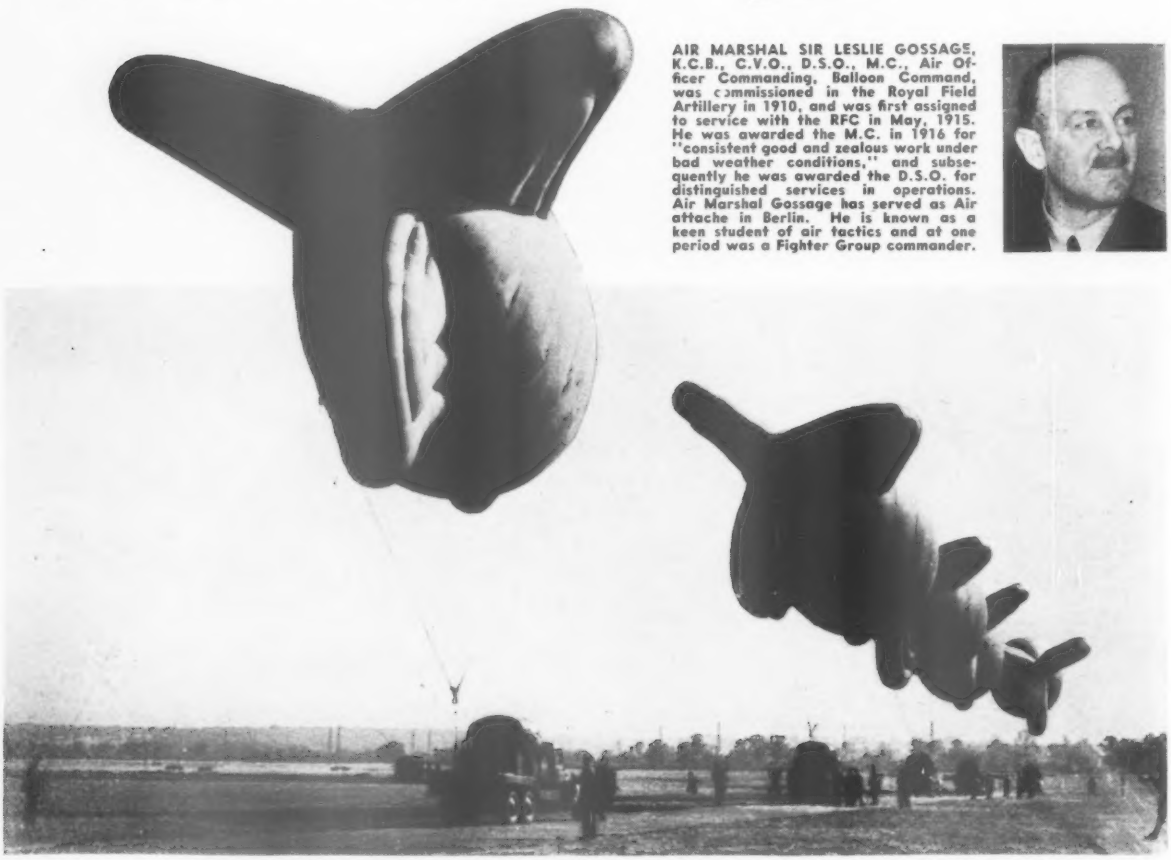
BALLOON COMMAND

British cities and convoys are protected from enemy dive bombers by these ugly, invaluable "rubber cows."

Herded by their motor tenders, these barrage balloons are going out to their posts.

BALLOON COMMAND

by Air Marshal Sir Leslie Gossage



AIR MARSHAL SIR LESLIE GOSSAGE, K.C.B., C.V.O., D.S.O., M.C., Air Officer Commanding, Balloon Command, was commissioned in the Royal Field Artillery in 1910, and was first assigned to service with the RFC in May, 1915. He was awarded the M.C. in 1916 for "consistent good and zealous work under bad weather conditions," and subsequently he was awarded the D.S.O. for distinguished services in operations. Air Marshal Gossage has served as Air attache in Berlin. He is known as a keen student of air tactics and at one period was a Fighter Group commander.

Balloon operation is a highly skilled job, demanding knowledge of knots, splicing, sewing, stresses and properties of hydrogen. Note perfect alignment of balloons at training school drill, above.

AT 10 minutes to nine on the fine morning of the last day of August, 1940, the Germans gave a clear indication of their respect for the British balloon barrage—in their own language. They came across to Dover, and in six minutes shot down every one of the 23 balloons flying there.

The Battle of Britain had been joined: and the Dover balloons represented the first line of our passive defence. The barrage had been deployed during July as a protection against dive bombing. The fact that it still flies in full view of the enemy is proof that the attack was not successful in the long run. The part of balloons in the Battle of Britain may seem comparatively slight, but this incident at least confirmed the value of barrage protection, first by the enemy's interest in attacking it, secondly by the failure of that attack to prevent a balloon barrage being flown at Dover.

The attack began when two waves of about 50 enemy aircraft approached Dover flying at heights ranging from 15,000 to 20,000 feet. Six Messerschmitt Me-109's broke away from these formations and flew at the balloons. The fighters appeared to have discovered lanes in the antiaircraft barrage, which had been caused by the removal of a certain number of guns for use elsewhere. Their attack was more successful than any subsequent attack made, but they lost half their force.

Of the six, two were destroyed by antiaircraft fire, and a third by rifle fire from balloon crews.

There were no casualties among the balloon operators and replacements were immediately put in hand. One balloon site raised a new balloon with 40 minutes of the attack. At 11:30 that same morning 11 balloons were again flying over Dover and by the same afternoon their number was increased to 18.

At 7:30 in the evening the Germans tried again and succeeded in shooting 15 balloons down. Despite these losses however, there were 16 balloons flying over Dover on the following morning.

When these were attacked three enemy aircraft were shot down at a cost of only two balloons. The crew of a site in the centre of the town lost their balloon but reported as follows: "The enemy aircraft attacked a balloon which was rising just inflated in the harbour. A 50-round burst of controlled rifle fire staggered the machine which banked up, clearly disclosing underpart and markings. A second burst of 20 rounds was fired and black smoke was seen coming from the engine and the machine dived into the sea beyond the breakwater."

The protective balloons still fly over Dover. The attack on the barrage has proved too costly. Subsequent attacks appear to represent individual acts of daring by members of the Luftwaffe and are said to be frowned upon by the German authorities.

In general, major attacks on balloon barrages have ceased, the enemy having realised that the game is not worth the candle.

The fact, however, that he hoped to destroy our balloons is in itself proof of the utility of the barrage.

Balloons are deployed to drive the enemy to a height from which accurate bombing is difficult, rather than to net him.

Waterborne barrage balloons provide protection to coastal shipping. Gas cylinders are kept on deck, ready for use.

Nicknamed "pigs" by their handlers, barrage balloons draw their gas from batteries of hydrogen cylinders, as above.

That they succeed in doing so is noted by William Shirer, who in "Berlin Diary" states the attitude of German pilots toward the London barrage:

"He (one of the German pilots) relates that they approached London at a height of from 15/16,000 feet, dived to about 10,000 feet and released their bombs at this height—too high for accurate night bombing. They did not dare to go below 7,000 feet, he says, on account of the barrage balloons."

Apart from attempts at shooting down barrages, the Germans have shown their balloon wariness in a more positive form. Balloon fenders have been found upon enemy aircraft brought down in this country. These are guards stretching from each wing tip to the nose and consist of a streamlined shell of light alloy reinforced with a strip of steel along the leading edge. They are held in position by five outrigger struts, one projecting in front of the nose and two projecting from each outer wing, thus forming a sort of flattened V in front of the aircraft.

It is intended that these fenders shall be strong enough to break the balloon cables by impact or to thrust them aside; but they weigh about 800 pounds and reduce the performance of the aircraft very considerably.

A balloon barrage is deployed to protect a vulnerable point or a vulnerable area. This may be a harbour such as Dover, a city such as London, dockyard installations such as those at Liverpool, or individual factories doing work of vital importance—for instance, the manufacture of aircraft. Whatever they protect, however, balloons are never intended as a complete and independent form of air protection. In keeping the attackers up, in restricting their area of attack and in placing them at a level favourable to antiaircraft guns they are playing an essential part in the general scheme of defence, enabling fighter aircraft, antiaircraft guns and the observer system to co-operate effectively.

Since September, 1939, the citizens of London have enjoyed the visible security of the silver barrage studding the threatening blue skies. The balloons flew night and day throughout the most severe aerial bombardments. The fact that our industrial effort has never collapsed and that the vital ports of this country are still open, is partly due to this passive defence so doggedly maintained.

The conception of balloons as a weapon of air defence originated before the last war. The idea was to build a stockade of nets in the skies and to enmesh hostile aircraft on their way to a defended area. The Germans tried a form of balloon or kite barrage as early as the winter of 1914-15. By March, 1917, they were forming balloon barrage detachments to protect important industrial establishments.

An early deployment of balloons by the Allies was in Venice, where there were seven balloon stations each provided with 10 balloons. These were inflated during each moonlight period and flown at the height of about 10,000 feet from rafts moored about 200 feet apart round the outskirts of Venice. In June, 1917, a Royal Flying Corps officer was sent to Italy to report on the scheme. On September 5th of that year Maj. Gen. E. B. Ashmore, who commanded the London Air Defence Area, put forward his scheme for a London balloon barrage. His suggestion was for an apron consisting of a row of balloons connected by a cross cable carrying weighted wire streamers. His scheme was approved by the Government and on September 19th he announced that he was arranging to install two balloon aprons on the easterly borders of London.

In October, the Commander-in-Chief, Home Forces agreed to the establishment of a Home Wing of five balloon squadrons requiring a total personnel of 3,587, at the same time giving his approval for "the installation of a cordon of 20 balloon aprons, approximately on the line—Tottenham, Ilford, Barking, Woolwich and Lewisham, subject to such modifications as experience may suggest." By April, 1918, seven of the aprons were in operation and an eighth was nearly ready.

The balloon aprons acted as a kind of stockade against enemy aircraft. The position was carefully checked by our own fighter patrols, and the beginning of the present strategy in air defence may be seen in the close co-operation between fighters, antiaircraft, lights and balloons. The stockade of balloons, however, had the disadvantage of being heavy and

Cables, invisible in photograph, control balloon position, force enemy planes to higher, less effective, altitudes.

A convoy under way, protected by a balloon canopy. Note ease with which operator controls balloon sway by hand.

inflexible. It was difficult to operate and its weight was a potential menace to the population it was designed to protect. But the success of the balloon aprons as a scarecrow is borne out by the records of the enemy. In March, 1918, a report was made to General von Hoeppner to the effect that the aprons had increased enormously, and added greatly to the difficulties of the attack. If they were increased and improved much more (the report stated), they would make a raid on London almost impossible.

When the barrage was hauled down at the end of the war, work on defensive balloons lapsed, though their squadron establishment was always maintained for experimental work. The conception of a balloon barrage never died out. The almost certain necessity of having to organise and maintain a barrage in any future war was noted by the Air Defence of Great Britain Command at various times between 1928 and 1935. An Air Staff decision was taken in 1936, to establish a barrage in London, the possibilities of barrages in provincial districts being left open until some experience had been gained on the working of the barrage in the metropolis.

Early in 1938, after considerable research and planning, the recruiting of the first balloon squadrons was put in hand. A balloon training school was opened and the nucleus of regular personnel was given an intensive course of training before being distributed to the various centres in the formation.

Shortly after the international crisis in September, 1938, it was decided to proceed with the establishment of barrages in many of the important provincial cities. At the same time it was decided to establish an individual Balloon Command Headquarters. Early in 1939, the provincial groups were established on a skeleton basis and sufficient progress had been made in their organisation and equipment to enable the whole barrage for the country to be mobilised on the outbreak of war.

The Air Officer Commanding-in-Chief, Fighter Command is responsible in the first place for the control of the balloon barrage. The chain of Command is derived from him as follows:

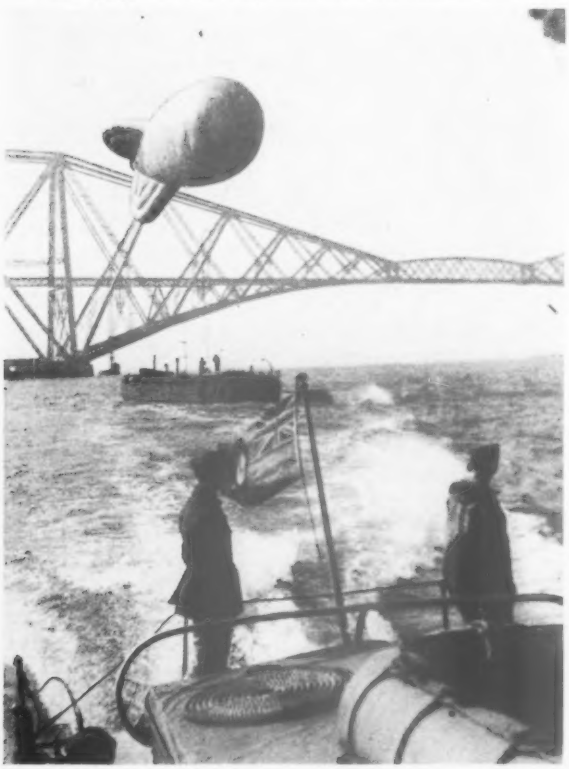
The Air Officer Commanding-in-Chief, Fighter Command.
The Air Officer Commanding, Balloon Command
Balloon Groups
Barrage Control
Squadrons
Flights
Sites

In addition to the general operational control and to the exigencies of the weather, barrages are naturally subject to some local control. Those operating in the neighbourhood of an aircraft base, for instance, will be subject to those in charge of aircraft control; those guarding aircraft factories must often provide controllable lanes through which aircraft may be admitted to the factory landing ground.

Though their main function is to "position the pheasant,"

(*Continued on page* 216)

Famed Firth of Forth bridge, Scotland, is protected from low flying Nazi attacks by means of waterborne balloons.



Members of the WAAF are relieving men in many operations of the Balloon Command. Here they control a rising "pig."

MAINTENANCE COMMAND

AIR MARSHAL SIR JOHN BRADLEY, K.C.B., C.B.E., AIR OFFICER COMMANDING-in-CHIEF, MAINTENANCE COMMAND, is one of many senior officers who entered the Royal Air Force from the Army, having served with the East Yorkshire Regiment during World War I, before being granted a permanent commission in the Royal Air Force in 1919. Sir John was appointed to his present post in March, 1938.

by J. C. Bradley

MAINTENANCE COMMAND was formed in August, 1938, to take over the maintenance units which at that time were administered by the Air Ministry. This reorganisation aimed at securing rapid expansion and flexibility. Even in those days the task was considerable. Today, four years later, the job has grown to 20 times its original size.

The Command badge is a raven. Eagles may soar, but it is the ravens who provide. Beneath the appropriate emblem is one word: Service—an exact description of the tasks performed. The first stage in understanding them is to see how they fit into the whole. Manufacture is in the hands of the Ministry of Aircraft Production and the Ministry of Supply, and operational servicing is done by airfield ground-staff; but the entire range of service, linking industry with operational flying, is the work of Maintenance Command.

When an aircraft leaves the factory, the Command takes charge of it for storage, final equipment, and delivery; and when wear and tear, accident, or enemy action damage it beyond the facilities of the operational unit, Maintenance Command again takes over, working against the clock to get it back into action. But the Command is not only responsible for aircraft: if food, stationery, and building materials are excepted, it is true to say that the Command exists to supply every material requirement, whether routine or emergency, to both men and machines in the RAF.

The range is enormous. In the huge "Vocabulary," as the catalogue of spares and equipment is called, more than three quarters of a million separate items are listed. There you will find noted the smallest screw and the complete engine, the minute 1/64" drill and the huge four-bladed propeller, the pilot's high-altitude flying-suit and the WAAF's stockings.

Everything is carefully indexed so that a brief signal can describe it accurately, and a day-to-day stocktaking system based on the most advanced accounting methods keeps track of the totals. Ask how many gun turrets of the newest pattern will be available tomorrow, or how many stewpans were sent to a lonely point in the Hebrides the day before yesterday and, without a flicker of an eyelid, the information comes to hand. But there is not one unnecessary piece of paper; purely clerical work has been cut to a minimum, with a gain rather than a loss of efficiency.

Whenever a problem has arisen the practice has been to make use of the best business experience available. For example a football "pools" chief was called in to advise on the rapid handling of vouchers; for dealing with a multitude of small items the Command consulted the fixed-price chain stores; and transport problems were solved with the co-operation of a firm of haulage contractors. In this way a system was built up which sought to combine all that was most useful in a dozen other systems, each the best of its kind.

The basic organisation of the Command is a logical consequence of the wide range of its work. In principle it is functional, the different duties being divided between four specialist Groups, each covering the entire country, and also the two independent wings.

One wing controls the packing organisation for all the aircraft which are to be shipped to our Allies, the Dominions and to all the theatres of war overseas.

The other is the Mechanical Transport Wing which administers the specialised Mechanical Transport (Truck) companies. Some are lifting companies to assist the operational moves of certain squadrons. Others are port squadrons which are used for the loading and the unloading of shipping.

The Aircraft Group stores the planes which are delivered from the factories by the Air Transport Auxiliary pilots, and arranges their distribution. Often these aircraft, though fit for flying, are not completely equipped. During storage they are brought up to operational standard, necessary parts being added. It may be that an improvement of some component has been decided on, but before the change can be incorporated in the production line a number of aircraft have been completed and sent to store. Maintenance Command must see to it that the improved part is added to the stored planes.

Sometimes a component is considered too delicate for factory fitting, or because of its secret nature is unsuitable for exposure to the chance contacts inevitable in a large works. In such cases the aircraft group undertakes a last-minute fitting.

Storage in wartime implies dispersal, a fact which greatly complicates the task. New aircraft may be needed at short notice, but it is imperative that while held in reserve they shall be widely scattered. Shrewd planning is necessary to meet such conflicting necessities, and carefully contrived camouflage and dispersal have in fact ensured that our losses, from bombing have been negligible.

Apart from the main difficulty of dispersal, storage problems are many. Turnover is reasonably high, but constant inspection is necessary to guard against deterioration in storage; and the conditions to which certain fabrics or substances are unduly sensitive must be known and avoided. These matters require highly specialized knowledge the importance of which, though unspectacular, must not be underestimated. The modern aircraft, which may be an instrument of almost fabulous cost, can receive the most serious damage through ignorance or carelessness at any stage of its handling.

The equipment group particularly merits the raven badge, for it is the universal provider, handling engines, instruments, weapons, vehicles, balloons—and all spare parts and other gear connected with their use, the requirements of personnel and highly-technical ground equipment included. Items received into stock are either new production from industry or the work of contractors and government depots responsible for repairs. So high is the standard of repair work that the results are regarded as equal to new. The stores are of necessity immense, and the calls upon them continuous and heavy. A single order from a bomber station may cover an extraordinary range of requirements.

Soon a huge lorry will collect them and they will be on their way. The country is divided into seven delivery areas, and even the most remote operational units are visited normally every 48 hours.

The handling of explosives is a highly specialised task and the third group which is responsible for this part of the work of the Command differs from the others in that it is staffed almost entirely by service men, though certain of its expert advisors are civilians. In addition to the storage and delivery of bombs, this Group deals with ammunition, pyrotechnics, oxygen and petrol. Here again dispersal is an obvious necessity, the problem being to keep airfields constantly supplied while avoiding the accumulation of explosives at danger points. The main holdings are sometimes tunnels deep in hillsides, but it is not so easy to furnish the same high degree of protection for the intermediate distribution points known as "parks." Here careful dispersal and camouflage is all that is possible, for the rate of turnover is too high to admit of other precautions being taken.

The fourth and last group is responsible for the repair and

(*Continued on page 270*)

These are Lockheed "Hudsons" waiting to be ferried to England. The airport is a ferry base in Newfoundland.

FERRY COMMAND

Hundreds of sorely needed operational planes have been flown to Allied forces all over the world. Honors for this amazing work belong to the unsung, hard-working ferry pilot.

by F. W. Bowhill

AIR CHIEF MARSHAL SIR FREDERICK W. BOWHILL, G.B.E., K.C.B., C.M.G., D.S.O., Air Officer Commanding-in-Chief, Ferry Command, was one of the first two men to fly an aircraft off the deck of a warship, and also commanded one of Britain's first aircraft carriers, the *Empress*. Also served with the R.N.A.S. Born September 1, 1880, in India, he was educated at Blackheath and the Royal Navy school, H.M.S. Worcester. He was an officer in the Merchant Service from 1896 to 1912; he started flying in the latter year. He has commanded Ferry Command since 1941, having previously served (1937-41) as A.O.C.-in-C. Coastal Command.

THE medium and heavy bomber, and the long range boat, unlike all other war material produced in the United States and Canada does not require valuable shipping space to take it to the battle zones. So the war was only a few months old when negotiations began for the establishment of a Canada-Britain air mail service which could also lay the groundwork for a future bomber ferry to Great Britain.

Pioneering of the project was entrusted to Morris W. Wilson, president of the Royal Bank of Canada, who secured the help of Sir Edward Beattie, chairman of the Canadian Pacific Railway and the Canadian Pacific Air Service. Under their guidance the planning and execution of the scheme were rapid and effective.

A group of experienced pilots was sent to Canada from Britain to inaugurate the ferry. All were men well known on the world's civil air routes. Among them Capt. A. S. Wilcockson, Capt. Donald Ross, Capt. D. C. T. Bennett, D.S.O. and Capt. Humphrey Page.

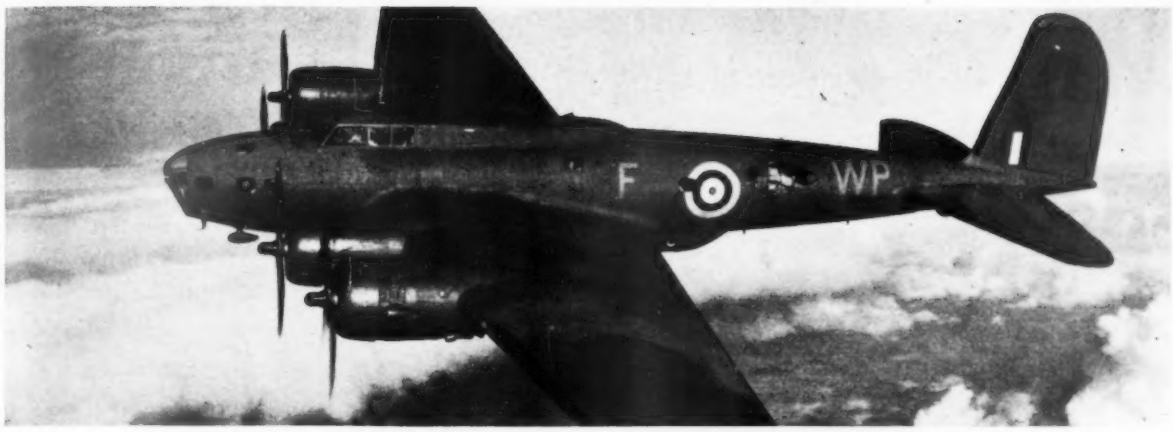
From the first weeks there was a steady flow in of civilian pilots from the USA and Canada, as well as from the Allied nations and from other British dominions. They were reinforced by pilots with war experience from the RAF Coastal Command, of which I was then commander-in-chief. A transatlantic ferry pilot school was opened in Canada in November, 1940.

In the control room of a British ferry terminal WAAF help check on aircraft over the Atlantic.

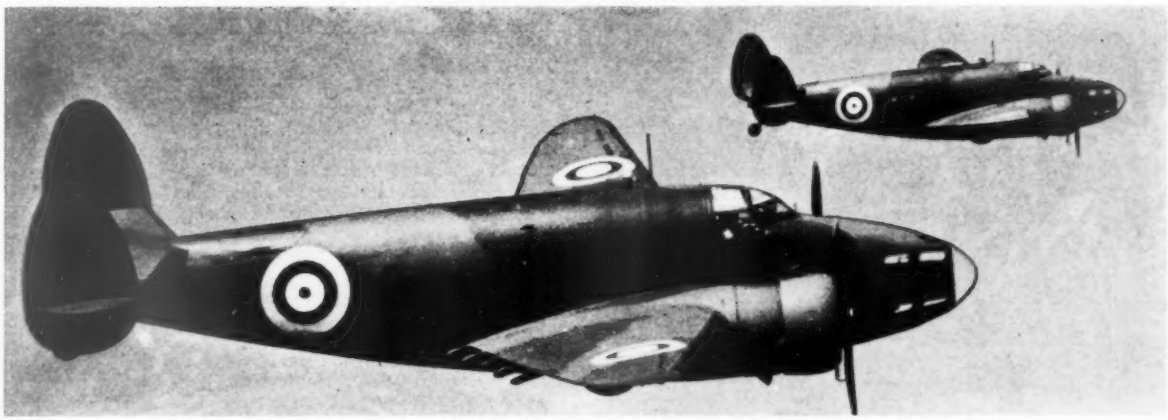
The first transatlantic delivery of American-built bombers to the RAF in Britain took place on Armistice Day, November 11, 1940, when seven Lockheed *Hudsons* took off from Newfoundland under Capt. D. C. T. Bennett. The flight was smoothly and successfully completed in less than 10 hours, and was quickly followed by the dispatch of the remainder of a consignment of 50 *Hudsons*, which had been flown to the Canadian border from Burbank, Calif.

These preliminary trials in regular Atlantic flight—now a routine everyday event—were organised from Montreal where St. Hubert was the main ferry base.

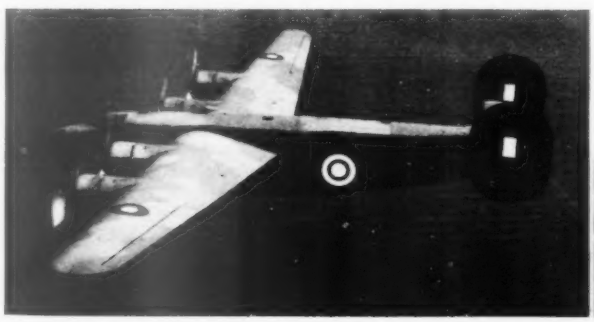
The early operations of the Atlantic ferry, showed that the maximum available output from the United States factories, whatever peak it



An early model of a Boeing "Flying Fortress," being flown across ocean.

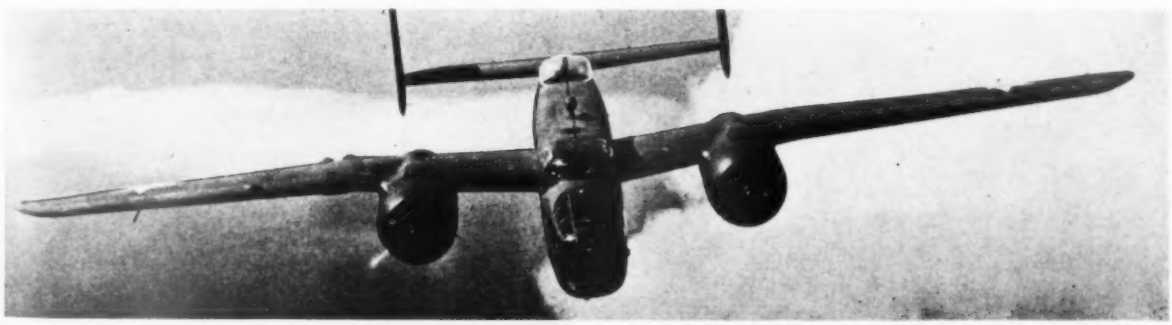


The Lockheed "Hudson" was the first American-built type to be flown to England by Ferry Command pilots.



Being flown across in large numbers, and also used as an ocean transport, is the Consolidated "Liberator" (B-24).

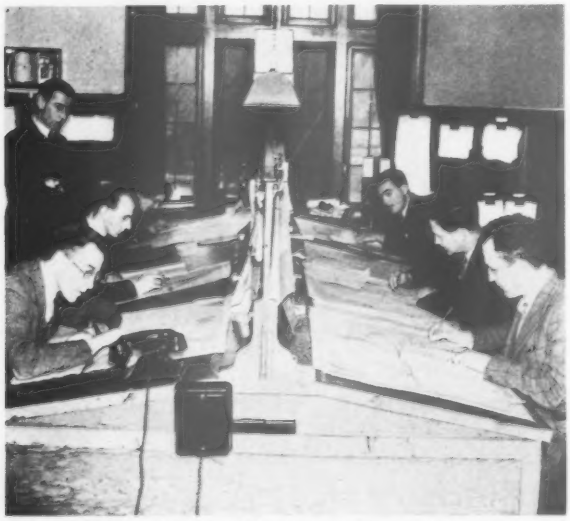
Another type frequently seen on the ferrying route is the Consolidated "Catalina." That above is the amphibian model.



Also on order for the RAF now is the North American "Mitchell" (B-25) twin-engined bomber.

Limited radio conversations between the ferrying crew and RAF ground stations are permitted as they near their base.

At a British terminal the flying control officer checks on an incoming bomber. Control tower is much like those in U. S.



Meteoro'ogical forecasts for the Ferry Command are made at this RAF base in Britain. Forecasters are civilian experts.

might ultimately reach, could be readily absorbed in Canada and promptly and safely flown to Britain with the utmost economy in manpower and cost.

In March, 1941, the bomber ferry came under the control of the British Ministry of Aircraft Production and was given the title Atfero (Atlantic Ferry Organisation), with Morris W. Wilson at the head and Harold M. Long, a steel expert, as his chief executive.

Atfero survived for only a few months but this was due wholly to a momentous offer from Washington, D. C. This offer, it can now be told, was made in June, 1941, when the President of the United States informed the British Prime Minister that his government was prepared to help Britain's war effort further first by allowing the U. S. Army Air Corps [now Forces] Ferry Command, with service pilots, to ferry all aircraft destined for Britain from the west coast of America to Montreal or any other Canadian airport and, secondly, by releasing U. S. civilian pilots to British service to help fly the aircraft across the Atlantic.

The first part of this magnificent offer could produce only greater efficiency and speed in delivery; the second part was a godsend to the RAF at the time. It meant the return to their squadrons for operational duties of a large number of RAF pilots who had been loaned to the Atlantic ferry.

A short time afterwards the British Air Ministry took over the Altantic ferry and I was honoured to be appointed to command it.

On July 20, 1941, Atfero was wound up and the RAF Ferry Command was formed.

I want to take this opportunity of paying tribute to the wonderful work which, I found, had been done, often in difficult circumstances, first by the Canadian Pacific Railroad and then by Atfero. Professional and business men, only a few of whose names I have mentioned, voluntarily and unsparingly gave their fulltime service to an unprecedented experiment in the newest phase of aviation without thought of any kind of reward and Canada has every reason to be proud of what they achieved.

The RAF Ferry Command moved its headquarters on October 4, 1941, to the new Montreal Airport at Dorval. The work of building this splendid airport—one of the best I have known, with uninterrupted approaches, modern layout and extensive facilities—had been practically completed in less than five months. Credit for this record performance belongs to the Canadian Department of Transport, represented on the spot by Comm. C. P. Edwards.

A transformation had been effected, too, in the forward base in Newfoundland, built on the site of an old forest camp alongside the railway, inaccessible by road, and with the widest runways of any aerodrome in the world. This airfield is under snow for more than six months in the year, but its runways are kept constantly clear by great rotary blowers which spray the snow into banks 16 to 20 feet high. Extensive reconstruction work had also been in progress at Bermuda, from which flying boats are dispatched, and other land and water bases have been laid out in areas which cannot yet be divulged.

I am assisted at Ferry Command by a senior air staff officer and an air officer in charge of administration. But their respective duties are, of necessity, very different from those of their counterparts in other commands. For instance, my S.A.S.O., has under him:

All flying personnel	Signals
Operations	Engineering
Service flying training	Meteorology
Civilian flying training	Traffic

Part of his responsibilities in connection with operations is to maintain the closest liaison with the U. S. Army Air Forces Ferry Command to ensure that the flow of aircraft from the factories will be in phase with our deliveries across the Atlantic.

He must also be in constant touch with the U. S. Navy, and the aircraft manufacturers regarding the supply and movements of flying boats. And he is never out of contact with the Royal Canadian Air Force regarding the numbers and training of pilots, navigators and wireless operators who will be available to us for ferry duty.

The air crews, service and civilian, are his responsibility in

(*Continued on page* 256)

A new surface of concrete is laid at an RAF base. This runway is 50 yards wide and will be camouflaged.

WORKS DIRECTORATE

Airport construction and maintenance is the responsibility of this organisation.

by E. Holloway

MR. ERNEST HOLLOWAY, C.B., O.B.E., DIRECTOR-GENERAL OF WORKS OF THE AIR MINISTRY, has held that title since 1939. Prior to that he was appointed assistant director, in 1934. In 1937 he became Deputy Director and Director of Works in July 1939. He was appointed Director-General in December 1940 and was awarded the C.B. in 1941. Born 1887, he was educated in England. In 1915, he enlisted in the R.F.C. where he served until 1919, during which time the RAF was formed. He entered civil service in 1919 and has followed his profession in that field ever since. His work for the Air Ministry has taken him to the Middle East and Aden. He once was chief engineer, Coastal Command.

THE man in the boat looked back at the trawler. Half-hidden by arctic rain, she lay head-on to the gale about a mile from the shore. Dirty, cramped, tossed like a cork, she had never looked so inviting as now. For ahead was a long spur of rock, climbed by the swell. His job was to land there. Somehow he had to get his camera, compass and instruments ashore.

The man at the small chugging engine seemed to think all this quite normal. You got alongside, he explained, and waited for the swell. In the trough you had 15 feet of smooth rock above you, but if you judged your jump nicely from the crest of a big one, it was a mere four to five.

The man with the instruments nodded. This was worse than most, but he was getting used to these landings by now. Three hours later, from a high ridge of granite, he was looking down on basaltic rock and peat bog across which an icy mist crawled towards him. Here, in the saddle between two barren ranges, somehow an airfield was to be carved.

No doubt the job would be hard, but he was completely confident. The last two years had taught him that, if you put your mind to it, airfields could be wrought from the most unpromising material. Sand, snowfield, a frozen lake; fenland or mountain valley—given brains, hard work, and a little luck it could be done. As for colossal difficulties, they weren't your chief worry. You could see them a mile off and you knew what to do. It was the unexpected, sometimes quite small snags that plagued you: a beautiful level stretch, and then try as you would not a blade of grass would grow; a perfect hidden valley, no floods in living memory—till you were well started, then inundation on biblical scale; or there were dawn mists at odd seasons which the inhabitants forgot to mention; or tricky winds from the hills which you only spotted when your runways were half completed; or sometimes firm land seemed to turn overnight into glue-like mud that no amount of drainage could get rid of—these were the things that made strong men grey at the temples. His own hair, incidentally, had a good deal more grey than that. Doubtless the dive-bombing in a certain fjord had contributed; and there were several summer afternoons during the Battle of Britain which had probably helped.

He set up his surveyor's compass and took a careful bearing. A week later the trawler put in once more. An unkempt figure scrambled along the rocks, slung his equipment down into the boat, and slithered after it. Next day, from a coastal airport, a plane took off for the south. Within 24 hours, in a building not far from Whitehall, a group of experts were considering a concise, informative, and highly confidential report.

It was all set down in black and white before them. Maps, panoramic skylines, climate and meteorology, water supply, possibilities of roads and bridges, details of nearby population, analyses of rock and soil. They sat in judgment at a long table. Meanwhile, a trawler was driving through sleet and spray. The man with the instruments was casting an expert eye on another coast.

One man looks at a desolate island; a dozen view a sheaf of reports. But if their verdict is favourable the huge organisa-

Runway-making is road-making on a large scale. Here a tarmac surface is being laid.

This giant scraper levels uneven ground before actual runway construction starts.

Heavy bombers require runways with solid foundations. This is a hard core being laid.

tion of that department of the Air Ministry known as Works Directorate comes swiftly into action. Where the lonely figure stood to take the first bearings, soon an advance survey party are setting up a battery of instruments. From that long shelf of rock where the long swell mounted, engineers are blasting a primitive quay. Now it is not a trawler riding the off-shore gale, but a small cargo vessel. Twenty or 30 men are coming ashore.

A month from now there will be hundreds, and in three months time a thousand. First a small camp at the foot of the hills; then gradually, a small town of huts and storehouses. The first rough quay will grow to a miniature port. Across the peat-bog, not built—for the peat is too fluid to take a true foundation, runs the first island road.

Lorries go floundering across it, and with them the flow of supplies. Wood, steel, cement—a hundred tons a day; then, as the work grows, two hundred tons. And food for a thousand workmen. Lorry after lorry piled high with food.

As for water, that presents only one difficulty. There's far too much of it. But one by one the streams are damned and diverted, forced into culverts and channels, drained away from that chosen strip of level ground. And while one lot of men are mastering the water, others are mastering the rock. Lumps that project are blasted and the debris used to fill up hollows. Small cranes appear; then as the foundations grow more solid, large ones. Soon great masses of rock are being slung into the air.

There comes a month of rain. It slashes at the men's faces, swells the hillside torrents, turns the peat to a devouring sea of slime. The road can't take the traffic; it's no use, the lorries can't get through. But if they don't there's an army of men without provisions; and the work will fall behind for want of materials.

In a peacetime job, the worst that could happen would be payment of an agreed penalty for construction falling short of contract time; but this job is part of a war, and if it's late there's no one can tell how great the penalty will be.

Planes from this airfield will dominate a stretch of Atlantic waters which the mainland bases now find it difficult to guard. Across the North Sea, despite the pounding of our bombers, U-boats are still coming down the slipways. We can delay their launching, not check it altogether. But the coming into service of this airfield will mean that one thousand square miles of ocean, or it may be even more, will be subject each day to double or treble scrutiny. The U-boat will be hunted down; the surface raider will be up against shore-based planes. If the work slows down, if it's not seven months but nine before the first planes take off from this island airfield, lost tonnage will measure the gravity of that 60 days delay.

So the column of lorries goes forward over the road which the rains have worked on. The first one gets by, and the second; the third slithers perilously, skids, lurches, and then is halted. One wheel is bogged, and the cumbrous bulk of the lorry is slung broadside across the road.

If 20 men can't move it, send for a hundred; if mechanical haulage can't get a purchase, send for horses; and meanwhile, shore up that other edge, there's just space for the rest of the line to crawl through. They do it, each one making a spurt at the critical moment, tottering on the slippery rim of the roadway, but righting and staggering on. The drivers crouch over the steering wheels, windscreens open to the cutting edge of the rain, their curses and shouts snatched from their lips by the gale that sweeps in from the sea.

A few weeks later there is hot sunshine and the road hardens. A dozen lorries are in the peat-bog and three times that number of men are in the rough field hospital—they couldn't be taken off till the gales died down. But not a day's work was lost in the whole bad season; and when the next rains come the road surface will have been strengthened and the drainage bettered. By that time, too, the concrete runways will be sliding away from beneath the wheels of the first fighter and reconnaissance planes.

By then past troubles will have become good stories—the day the big crane started slipping; the time the lorries were all stuck and the supplies went the last half mile on the backs of staggering men; the evening a Heinkel swooped out of the clouds and machine-gunned the jetty; the night the torpedoed supply ship was beached with half her bows blown away.

These stories are all part of the Battle of the Atlantic, a part not often told. But then the same was true of the Battle of Britain. While *Spitfires* and *Hurricanes* were shooting the yellow-nosed Messerschmitts out of the blue heavens, some of the men now at work on the northern island were sweating far nearer home, putting right by night airfields blasted by day; finishing the second-line field against the clock so that the fighters could still fly when their first-line aerodrome was half ruined; then getting the first one levelled before the bombers had spotted the other; eating and sleeping in snatches, bombed and machine-gunned on the job without the satisfaction of headlines to help them on their way.

These were the high spots, of course. Nine-tenths of the job for which the Directorate General of Works is responsible are devoid of thriller trimmings. They are just a matter of accurate calculation, perfect organising skill and steady drive. The main problem tackled can be summed up in a single American phrase: an air force has to be on the level. Planes may move freely in three dimensions, but for the start and finish of that movement they are tied to a level area. It must be the right size and have the right sort of surface; and if it is not plainly visible special lighting or directional beam apparatus must indicate its whereabouts. The surface may be a ship's deck or a stretch of water, a grassy field in the midland counties or a converted peat-bog on a rock-bound island; but it must be level. And the prairie dweller visiting the British Isles would be surprised to notice that good solid level ground is often quite hard to find.

Remember, then, when the radio announces that a thousand

(*Continued on page 242*)

Embryo flight mechanics learning their trade at one of the RAF's great technical training schools.

TRAINING AND MANPOWER

by A.G.R. Garrod

The RAF's training organisation is a vital factor in the attainment of air superiority by the Allied flying forces.

AIR MARSHAL A.G.R. GARROD, C.B., O.B.E., M.C., D.F.C., AIR MEMBER FOR TRAINING ON THE AIR COUNCIL, was appointed to his present post in July, 1940. He had previously served as Deputy Director of Organisation at the Air Ministry and Director of Equipment. In 1931, he served in Iraq on Air Staff operational duties. In World War I he entered service in the 3rd Battalion, Leicestershire Regiment, and was assigned to the Royal Flying Corps in 1915. He was awarded the M.C. in 1915 and the D.F.C. in 1919, and was three times mentioned in despatches. He was an RAF Staff College instructor.

AN expanding air force depends upon the efficiency of its training organisation. Training must not only be maintained at the high peacetime standard, it must also embody the lessons of war and impart the confidence and skill which before could only be gained in the first few months of squadron life. The pressure of war does not allow the finishing touches to be reserved for the front line units.

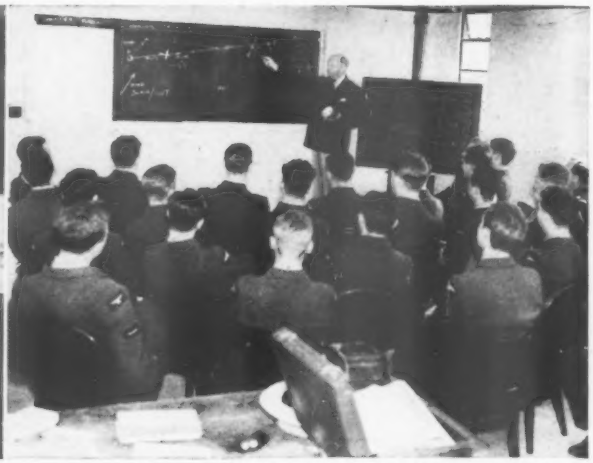
At the beginning of the war the Royal Air Force was a small but very highly trained organisation. It opposed the formidable German air force which had been built up through the preceding years with one aim—to achieve absolute mastery in the air. To this end the Germans had spared neither men nor material, for they believed that success in modern offensive war depended primarily on air superiority over the enemy. The first victory of the Royal Air Force was to deny this superiority to the Germans. Final victory will come with our own achievement of complete air superiority, and in attaining this the training organisation plays a vital part.

Since the outbreak of war, the Royal Air Force has expanded to many times its former size, until it is now capable of putting 1,000 bombers over Germany on one night. Its air crews come not only from the United Kingdom but from the Dominions and from the Allied Air Forces. Nearly all of them have received some part of their training in one of the great overseas training centres.

In the autumn of 1939, the United Kingdom, Canada, Australia and New Zealand agreed in conference at Ottawa to send their airmen to Canada for both elementary and advanced flying training. Separate agreements governed the setting up of training organisations in Australia and New Zealand as well. And later arrangements were made to transfer

Air Marshal J. T. Babington, C.B., C.B.E., D.S.O., (left) heads Technical Training Command; Air Marshal Sir William L. Welsh, K.C.B., D.S.C., A.F.C., Flying Training Command.

Modern war flying demands confidence and skill in every operation. Here, student pilots study up on navigation.



The navigating skill which guides RAF planes unerringly to enemy targets is being taught these embryo observers.

a large number of RAF air training schools to Canada. Air training on a large scale was also organised in the Union of South Africa and Southern Rhodesia, while later in Trinidad and Bermuda preliminary aircrew training was given to candidates recruited there.

Moreover, apart from these Dominion schemes the United States recently provided Britain not only with aircraft and equipment but with additional facilities for training in the United States. The first scheme to come into operation during the war was a refresher course for Americans and for British citizens in America who wished to join the RAF. This was followed by the opening, in civilian-operated establishments, of British flying training schools, at which pupil pilots from the United Kingdom were given elementary and advanced training on aerodromes specially constructed for their use. For instance, Pan American Airways run navigation training courses at Miami. Finally, in the spring of 1941, the U. S. Army Air Forces offered to allot part of their own training capacity for the elementary and advanced training of British pilots and crews, and the U. S. Naval air service gave us facilities at Grosse Ile and Pensacola for pilot and navigation training.

These training schemes in the Dominions and the United States gave the RAF the inestimable advantages not only of the enormous local resources, but of skilled auxiliary manpower, aerodromes in open country, freedom from enemy interference, absence of restricted areas and blackout conditions—and, above all, of the American climate which is ideal for the early stages of flying training.

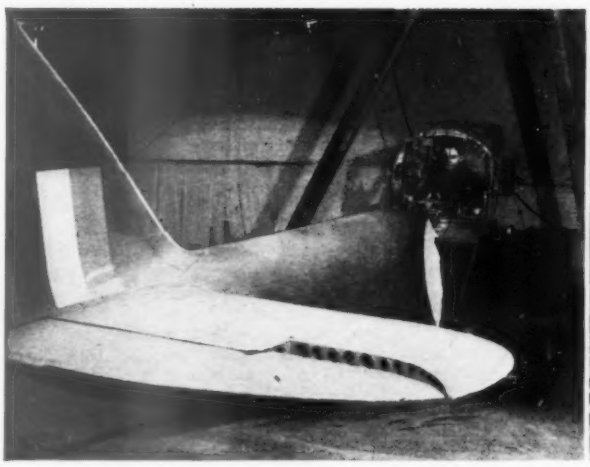
The responsibility for training in the RAF rests with the writer, who is a member of the Air Council and Air Member for Training. His Department, in conjunction with the headquarters of the dominion training organisations, settles training policy to conform with the operational requirements of the Air Staff. Each dominion is entirely responsible for the executive command and administration of its own organisation, but maintains close touch with the Air Ministry through its Air Headquarters or its liaison officer in London. The Department of the Air Member for Training is divided into directorates responsible for operational training, flying

Student RAF pilots in formation bombing practice over Southern Rhodesia. Planes are North American "Harvards," popular in RAF.

A formation of twin-engined Avro "Ansons," a type of trainer formerly used on reconnaissance operations.

At conclusion of lecture series, students progress to an Elementary Flying Training School. Plane is "Tiger Moth."

Before being posted to his bombing squadron, the student's final training includes study of the "office" of a "Whitley."

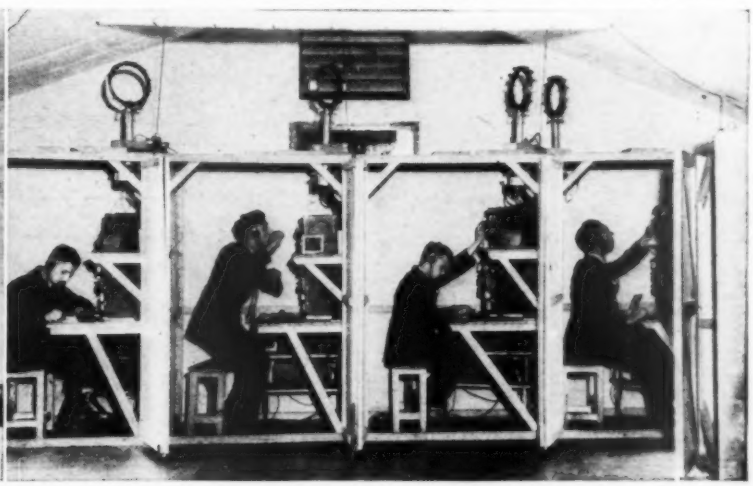


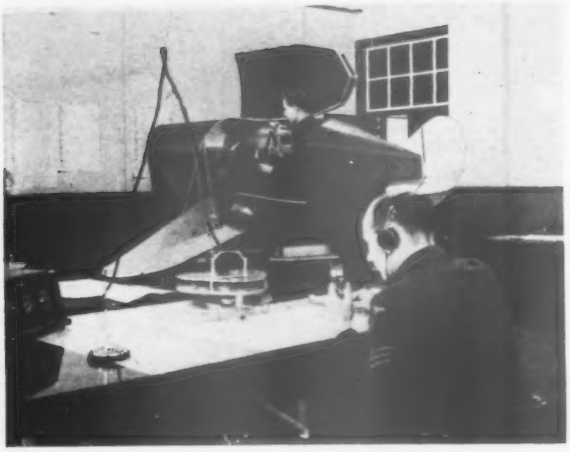
Turret gunners become familiar with vision restriction and "blind spots" through the use of this scale-built mock-up.

Armourers learn the intricate mechanism of every piece of the armament used in planes of each of the RAF Commands.

Study of the bomb-sight is one phase of an observer's course requiring special study.

The conditions to be met under actual flying conditions are simulated in each of these cubicles for the training of prospective RAF radio operators.





The Link Trainer, familiar to most American pilots, is used extensively by the RAF in its blind flying course.

training, technical training and administrative training. The Director of the Air Training Corps is also responsible to him. A Training Progress Branch undertakes statistical planning and the phasing of input and output at schools and a Training Adviser has been appointed who examines the human difficulties underlying the training system.

The executive command of the flying training units in the United Kingdom is vested in Flying Training Command, and Technical Training Command controls all ground training schools. The operational training units are controlled by the operational commands which they feed, for only these commands are in a position to know the exact requirements of their squadrons and the standard of training which the crews must attain before they are fit to fly on operations.

A large proportion of the young men now entering the RAF receive pre-entry training in the Air Training Corps or in similar organisations in the dominions. The value of the A.T.C. cannot be overestimated. Open to boys aged 16 and over, it affords two distinct courses. One is an air crew course comprising mathematics, navigation, Morse code, aircraft identification and RAF administration; the other, intended for boys mechanically or electrically minded, comprises wireless and mechanics, flight mechanics, electricity, and motor transport mechanics. In either case every effort is made through physical training to improve the physique of the boys. It is inevitable in a long war that there should be some falling off in the quality of recruits. The A.T.C., which now numbers some 200,000 boys, is the corrective; it fosters enthusiasm and esprit de corps, and stimulates the team spirit which is the foundation of successful training. The RAF and the Dominion air forces will come to rely on it more and more in the future.

It is a trying moment in a recruit's life when he faces the aviation candidates selection board. Already he has worked on an intelligence test and on mathematical and general knowledge papers; this is the final test. His education, his sports, his hobbies, his likes and dislikes are examined—why does he want to join the RAF? The youth moistens dry lips. "I want to fly." The president glances at him keenly. "Flying is only a means to an end," he points out, "and that is fighting. What do you want to fly?" "A fighter, sir." The president sighs.

Nearly all recruits want to fly fighters, for ever since the Battle of Britain to be a fighter pilot has been the ambition of every schoolboy. Yet the crew of a big bomber have an equally thrilling and even more exacting and responsible job. Well, the lad is a good type. He is intelligent, keen and cheerful, and he has passed his examinations well. The president smiles. "Right, we will pass you for aircrew, but whether you will become a pilot will depend on your own efforts during the early stages of your training. Good luck."

The youth leaves the board room with fast beating heart. Now he must pass the doctors. If there is anything wrong with him physically, they will discover it. The examination is meticulous, for operational service in the RAF demands a high standard of physique. He is passed fit for air crew duty. It only remains for him to be attested.

"I ..... swear by Almighty God that I will be faithful and bear true allegiance to His Majesty, King George the Sixth, His Heirs and Successors, and that I will, as in duty bound, honestly and faithfully defend His Majesty, His Heirs and Successors, in Person, Crown and Dignity against all enemies, and will observe and obey all orders of His Majesty, His Heirs and Successors, and of the Air Officers and Officers set over me. So help me God."

Now he is in the Royal Air Force.

He goes first to a receiving wing. Here he is kitted, drilled, lectured on various subjects, and in general introduced to service life and routine. Above all he learns that discipline is something much more than merely obeying orders. It is cheerfulness, alacrity, the desire to help others, a willing spirit of unselfish co-operation in a great service.

Then he passes to an initial training wing where he receives intensive instruction in the theory of flying, is introduced to air navigation and learns the elements of map reading and how to solve simple dead reckoning problems. He is initiated into the principles of deflection shooting by firing at clay pigeons. He learns Morse up to at least six words per minute, handles the Vickers machine gun, practises with rifle and revolver, and is instructed in signals organisation, aircraft recognition, and the physiological aspects of flying and first aid. At the same time his sense of discipline and mental alertness are fostered. He plays games and plays them hard, while drills are carried out in quick step at 140 a minute. If there is any physical or mental weakness it is very likely to show up at the initial training wing.

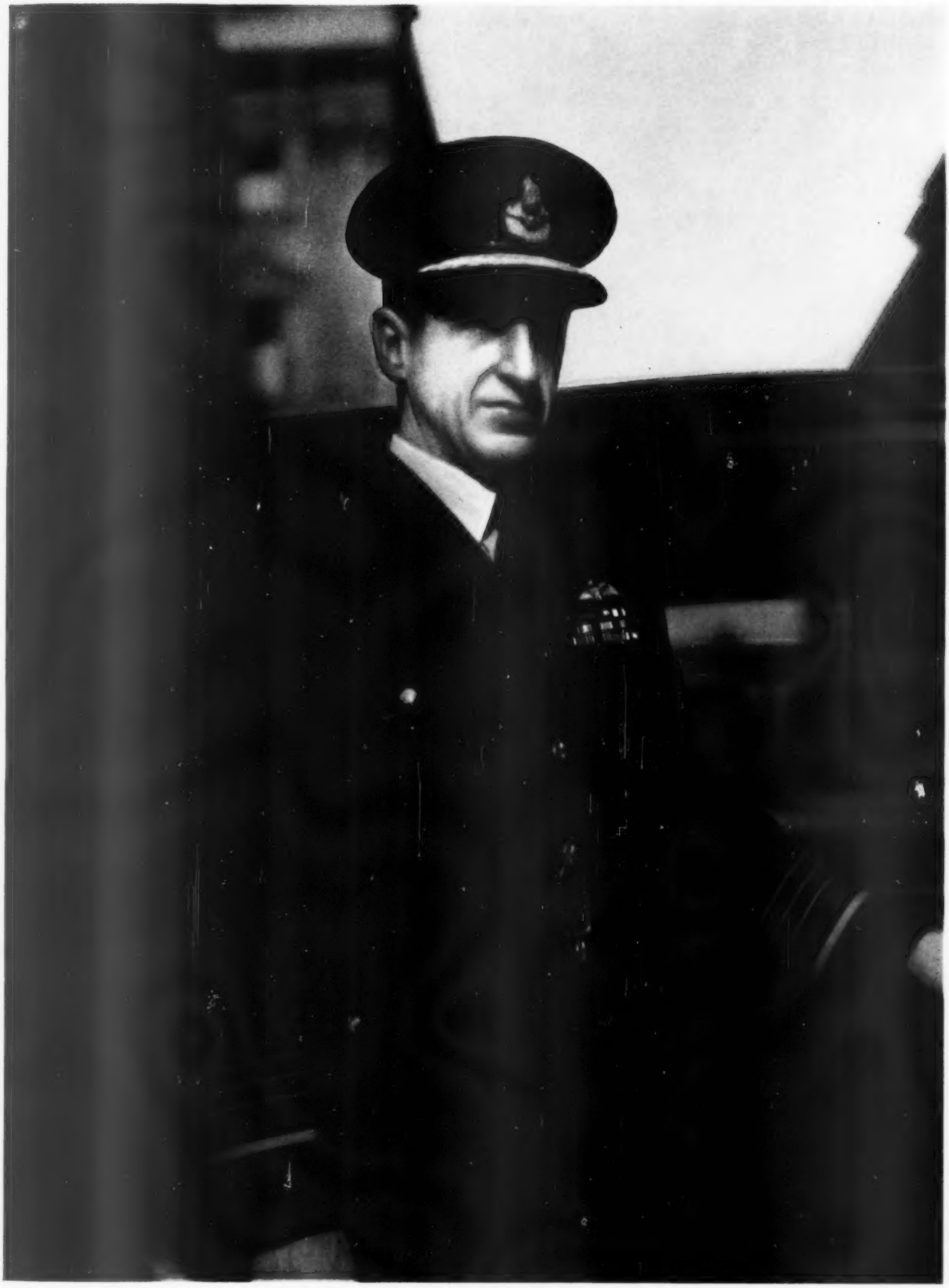
At length, exams passed, comes his flying test. This will determine whether he will continue his training as a pilot or as a navigator or air bomber. If he is selected as a pilot he will go overseas for his elementary and service flying training.

At the elementary flying training school he will learn to fly a trainer type of aircraft and will be given instruction in the theory of flight, airmanship, aircraft recognition, meteorology, navigation, signals, drill and physical training. He is also given instruction in instrument flying in the Link trainer, and is encouraged to take part in discussions and debates. The instructor plays an important role in fitting the pilot for the tasks ahead of him. He must be a good disciplinarian insisting upon punctuality, smartness and obedience to orders; be understanding, patient, tactful and watchful for any fault his pupil may develop. Above all, he must be constructive in his criticism. During the training period at an E.F.T.S. the in-

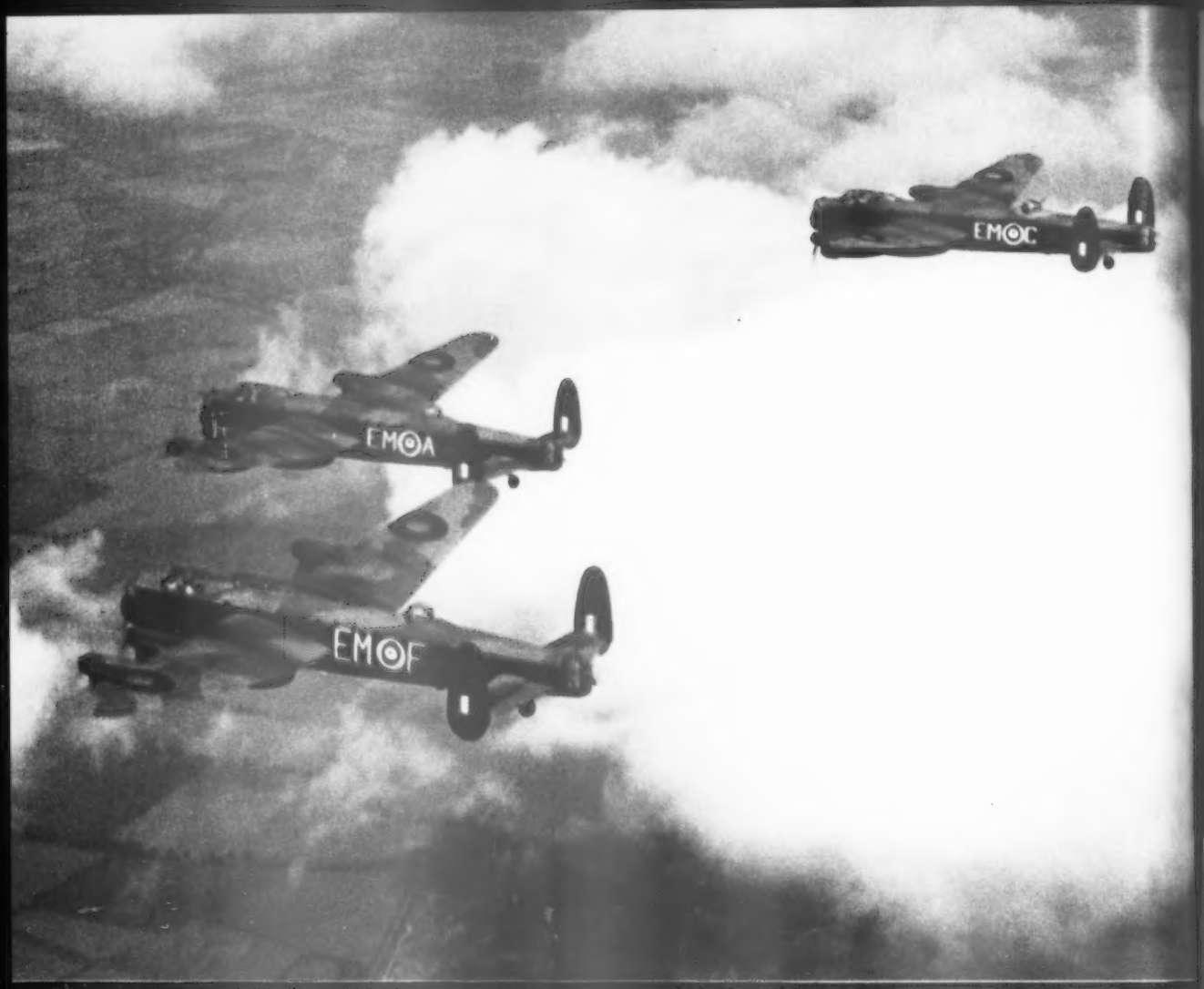
(Continued on page 206)

COLOUR PHOTOGRAPHY

Most of the colour photos on the following pages were taken particularly for this issue and flown across the Atlantic by Ferry Command bomber. They present a vivid panorama of the indomitable RAF.



Air Chief Marshal
SIR CHARLES F. A. PORTAL, G.C.B, D.S.O., M.C.
Chief of the Air Staff



One of the deadliest four-engined bombers used today, the Avro "Lancaster" is giant brother of "Manchester."

The Short "Stirling" is an RAF long-range mainstay. Total horsepower is 6,400; gross weight over 30 tons.

COLOSSUS

Mechanics at a Bomber Command base roll out a massive "Stirling" for an attack on Germany.

AERIAL DESTROYER

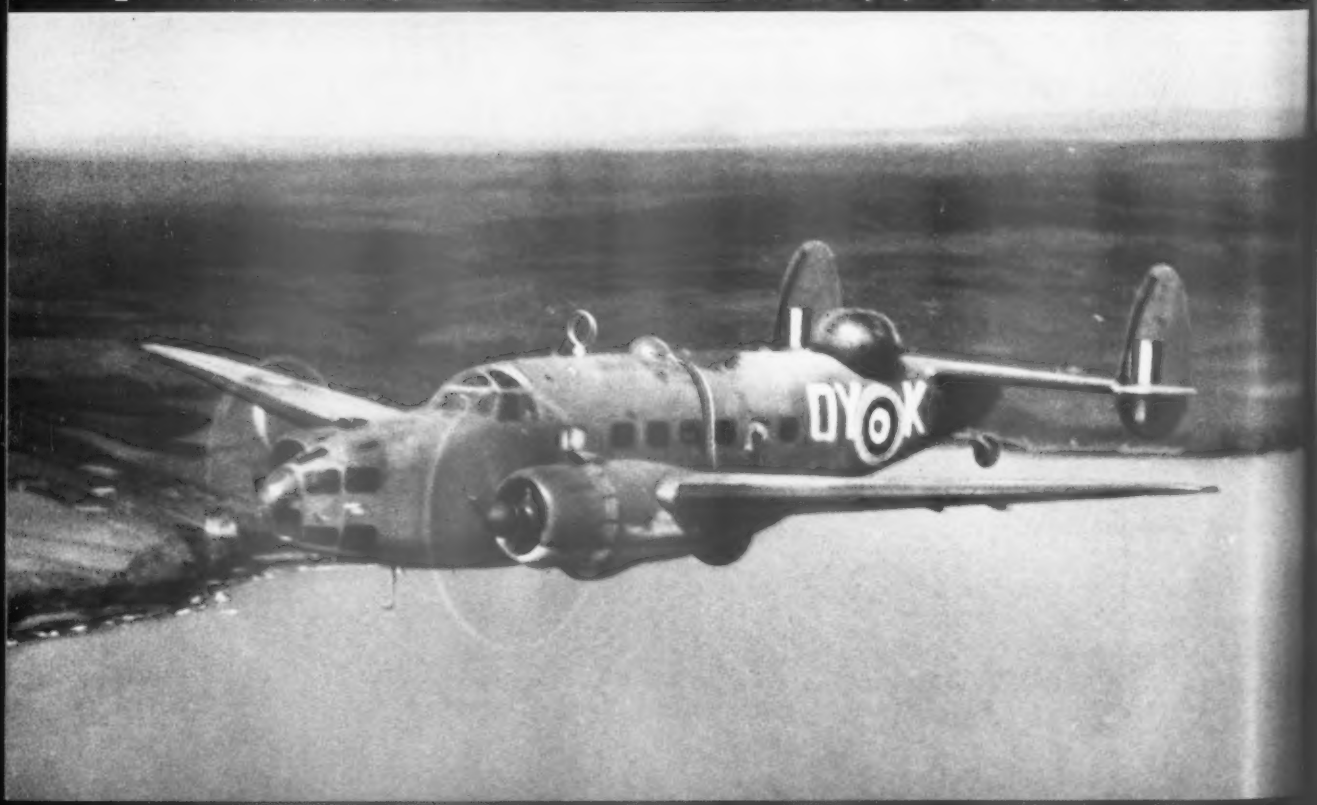
Scourge of enemy navies is the torpedo carried in the belly of this Bristol "Beaufort."

HORNETS

Frequent attackers of German targets in occupied France are these twin-engined Douglas "Bostons."

Consolidated "Liberators," four-engined landplanes from the U.S., are operated by the Coastal Command.

Oldest American type in the RAF, the Lockheed "Hudson" now is being augmented by the newer, larger "Ventura."



A Bomber Command veteran is the Vickers "Wellington." It carries a bomb load of 2,500 lbs. for 2,000 miles.

An old-timer still in use is the Handley-Page "Hampden." Short-ranged (1,725 miles), its top speed is 265 m.p.h.

Other member of RAF's four-engined bomber triumvirate is the Handley-Page "Halifax." Its four engines total 4,700 h.p. With "Lancasters" and "Stirlings," they nightly leave their mark on Germany.

Peer of all RAF fighters is the Supermarine "Spitfire." This is latest Mark V, with cannon and machine guns.

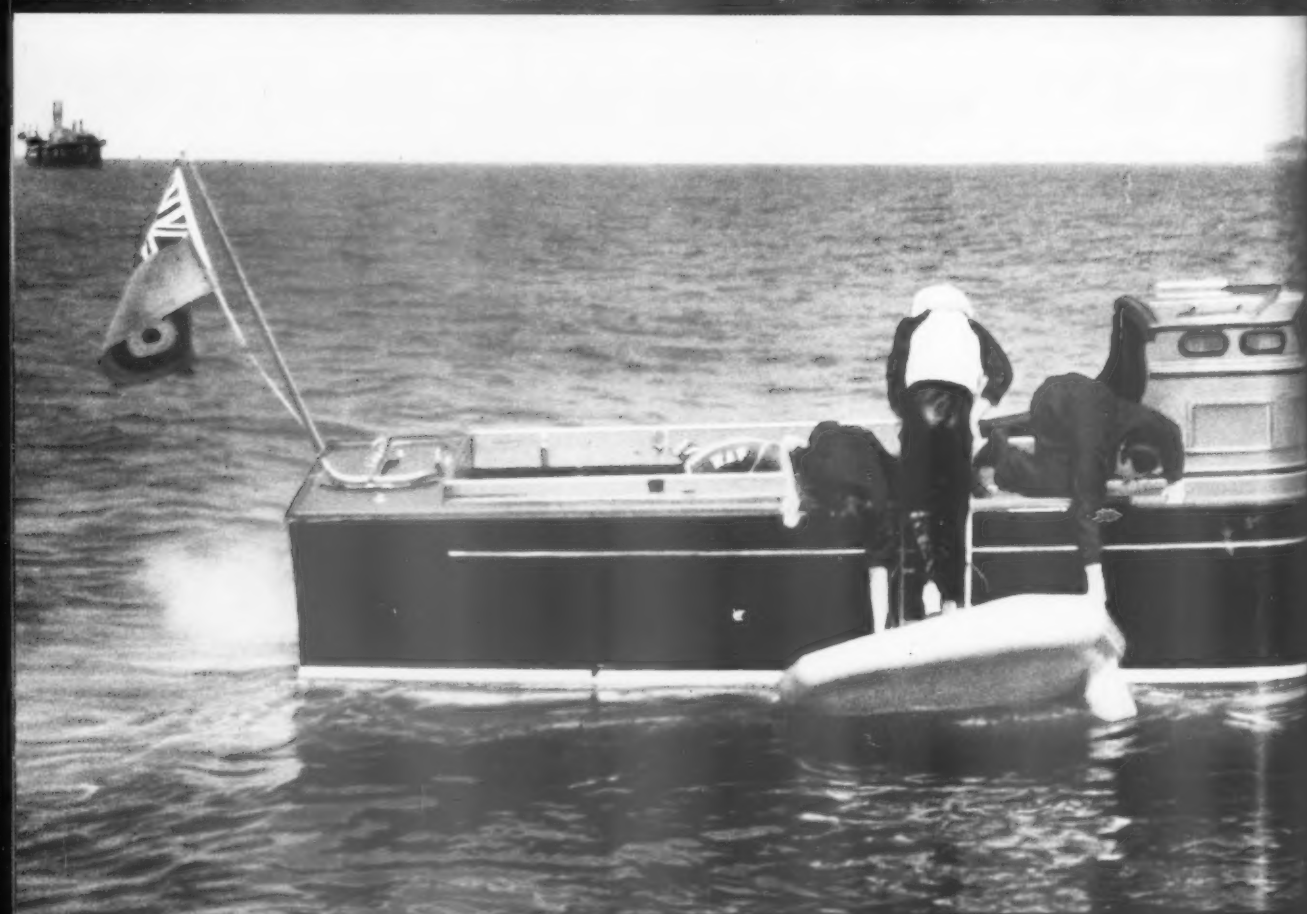
These are fighter pilots, those hard-fighting airmen who defeated the Luftwaffe in the Battle of Britain.

DESERT WARRIOR

The shark-toothed charger of this RAF pilot, photographed in the Libyan desert, is a Curtiss "Kittyhawk."

Fitted as a night fighter, this latest Hawker "Hurricane" carries four 20 mm. cannon. Maximum speed is 332 m.p.h.

This RAF fighter pilot, forced down at sea, floated in his life jacket until spotted by an air-sea rescue boat.



Carrying cannon and machine guns, Bristol "Beaufighter" is a long-range (1,500 miles) fighter and attack plane.

This "WAAF" (Women's Auxiliary Air Force) is operating a barrage balloon winch. U. S. adaptation of WAAF is the WAAC.

The Miles "Master" advanced trainer is an RAF pilot's last step before going to fighters like the "Spitfire."

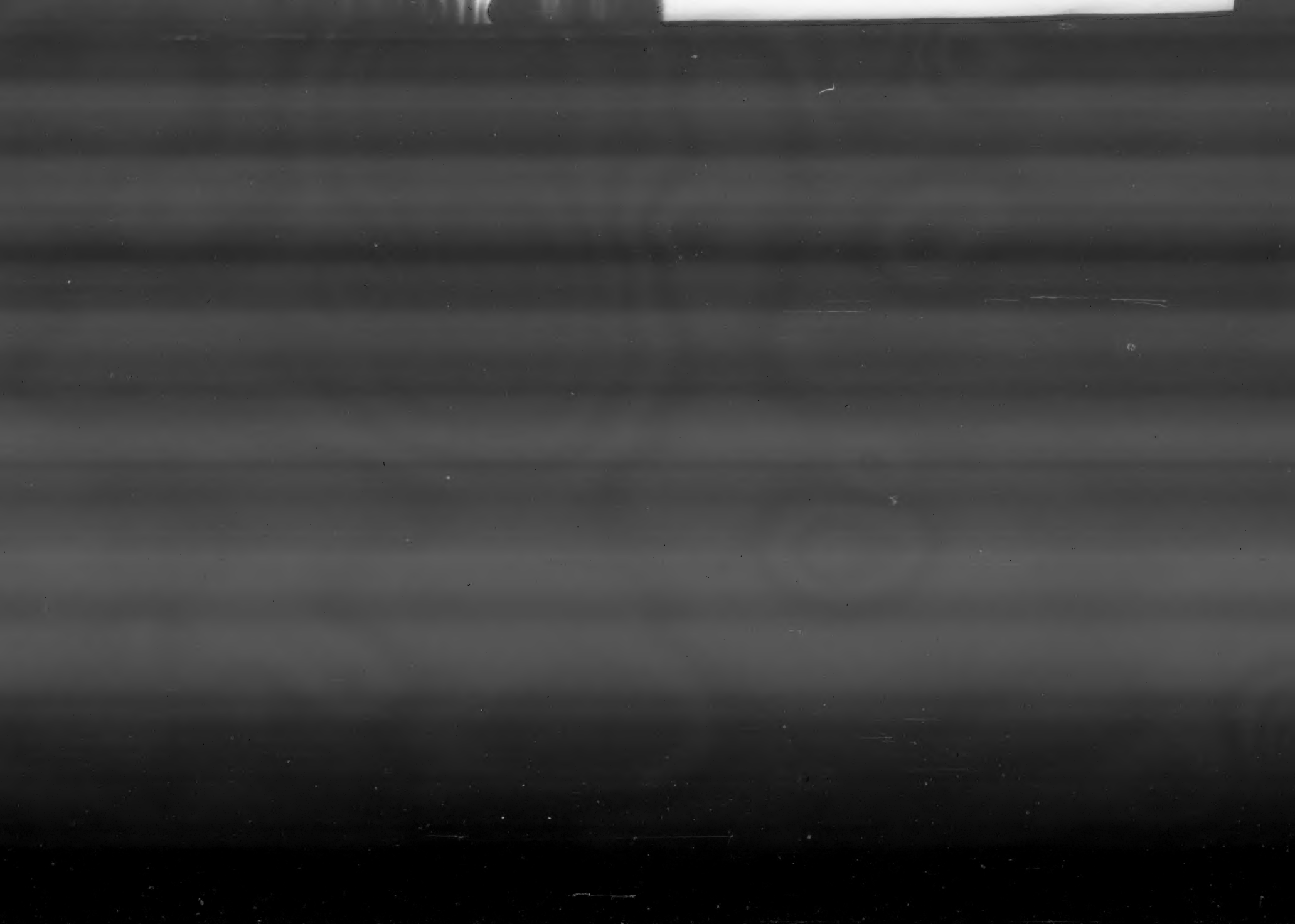
Barrage balloons, an important defense against low-flying enemy aircraft, are flown from boats accompanying convoys.

These are Tail-End Charlies, RAF air gunners, doing a bit of homework on practice targets at their base.

Two of the four giant powerplants of a heavy bomber get a careful checking by mechanics before a raid on Germany.

Back from convoy duty over the Atlantic, this Coastal Command Short "Sunderland" gets a checkup. Normal range is 2,880 miles.

Bright yellow paint is sprayed on life preservers of aircrew to insure their being spotted when forced down on the sea.



Night Landing of Cannon-Bearing Airacobra

...WH[illegible] COMES **Flying** HOME

Above the clouds, through the screaming sounds of a night attack, comes the staccato bark of guns. A cannon's cough pierces the rhythmic whine of screaming motors. There's a flash of flame.

Then, Johnny Comes Flying Home.

Those few seconds flash back seven years to the start of the fighter plane that has since captured the imagination of men, everywhere. It's the story of blood, sweat, toil and tears through the years when Axis danger seemed a fairy story.

Johnny is flying a heavily armed Army Airacobra. It's generally considered the most deadly fighter plane on wings. With speed, fire power and maneuverability on his side—with motor aft and guns out front—a cannon firing through the nose—the odds are with Johnny. Much of Aviation's finest skill has been busy for years giving Johnny those odds.

And it's never too early to say that we are looking forward to the day when Johnny will really come flying home, to find his place in a new world of peacetime aviation.

Stepped up by the needs of war, we know America will have the benefits of the mass production of planes to carry on its commerce and travel in the skies.

But Johnny must have those future planes of peace... and when the time comes, we at Bell Aircraft will be doing our part not to let Johnny down. © Bell Aircraft Corporation, Buffalo, New York.

Airacobras for victory—

FUTURE PLANES FOR PEACE

BELL *Aircraft*

PACEMAKER OF AVIATION PROGRESS

The Bell "Airacobra" courtesy of Bell Aircraft Corp.

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WOMEN'S AUXILIARY AIR FORCE

by

Trefusis Forbes

AIR COMMANDANT K. J. TREFUSIS FORBES, C.B.E., Director of the Women's Auxiliary Air Force, served during World War I with Women's Volunteer Reserve, and subsequently maintained active interest in women's service organisations. Miss Trefusis Forbes joined the Auxiliary Territorial Service in 1938—at the time of the Munich crisis—and in July, 1939, was appointed to the Air Ministry as Director of the WAAF with the rank of Senior Controller (now Air Commandant). Her relative RAF rank is Air Commodore.

WAAF plotters at work in an RAF operations room. These girls keep constant check on movements of friendly and enemy craft.

The author (centre) attends a London exhibition of garments knitted by members of the WAAF.

British women are fighting the war beside the men. The WAAF have proved so indispensable the U. S. Army recently set up their counterpart in this country.

THE waging of war is no longer an exclusively male undertaking. It is still customary to speak of "manpower," but by common acceptance the term is now more often than not taken to include women—the women who have cheerfully taken on men's jobs in factories, workshops, farms and offices so that manpower, in its strictly literal sense, may be utilised to the full.

In the Royal Air Force, the necessity for employing women to supplement man is thoroughly appreciated, and in consequence there has come into being the Women's Auxiliary Air Force. The extent to which this ancillary service has developed may be gauged from the fact that by the end of the second year of the war the total number of women enrolled into the WAAF was passing into the second hundred thousand—a figure higher than the entire strength of the RAF of a few years before. Moreover, a significant fact, every one of those women was a volunteer. Not only have they come from all corners of the British Isles to join the WAAF—there are also among them women from the Dominions and colonies. From friendly countries all over the world they came—including women from amongst those few who were able to escape from their Nazi-invaded homes. All of them—some who had seen service in the last war, others who had not long left school—left their homes, their jobs, their local ties to serve with the RAF.

From what may be termed the domestic and clerical jobs for which an active and intelligent woman is as suited as a man, more and more ground duties in the RAF have been allocated to the WAAF, sometimes to be shared with men, sometimes to be performed entirely by WAAF personnel. At the present time over 50 different "trades" are staffed with WAAF. In this way an impressive number of men have been released for the more strenuous or combatant duties, or retained in armament or other industries vital to the war effort where their special training is needed. Without that direct contribution to Britain's air effort from women of all classes the present strength of the RAF—already greater than that of the boasted Luftwaffe—might not have been achieved.

The Women's Auxiliary Air Force of today is the proud successor of the Women's Royal Air Force of the last war. Then, as now, it was found that women could work side by side with men on many jobs; although the process of absorption did not then go beyond their employment on such work as cooking, driving, orderly duties, stenography, telephony and storekeeping. But those pioneers proved their worth. And when, in 1938, serious attention was given to expanding Britain's defences, a Women's Auxiliary Service of part-time volunteers was formed under the joint auspices of the War Office and the Air Ministry. This was the Auxiliary Territorial Service (ATS). It had a number of RAF companies; but as it soon became apparent that many of the duties of women serving with the Air Force would be different from those required by the Army, the RAF auxiliaries were separated from the parent body. On June 28, 1939, the WAAF was constituted by Royal Warrant an integral part of the Royal Air Force, with its own officers and NCO's and its own uniform of Air Force blue.

The badges of rank of both officers and airwomen, as well as the colour and style of the uniforms, are identical with those of the officers and airmen of the RAF. This emphasizes the close connection of the WAAF with its parent fighting service.

When the Germans invaded Poland in September, 1939, the WAAF mustered 48 companies all told. Although they were graded into officers, NCO's and other ranks, all those volunteers

A Few of the Many

WAAF TRADES

1 In many cases WAAF girls are replacing men in operation of the balloon barrage.

2 Two members of the WAAF Service Police force, one of several WAAF branches.

3 WAAF experts' nimble fingers are particularly good at instrument repair work.

4 WAAF girls at work in an intelligence room, where reports from stations are gathered.

5 Refuelling of aircraft is another duty now being handled by WAAF personnel.

6 WAAF balloon operators hauling on the tail lines of a barrage balloon.

7 Another job in which girls are relieving men. WAAF meteorologists at work.

8 Now attending a special school, these are WAAF being trained in meteorology.

were regarded as potential officers or NCO's should the force be called upon to expand. War expansion of the RAF and the call-up of the Air Force reserves, required a great and rapid increase in the WAAF; a broadcast appeal for women volunteers brought thousands of women of all ages flocking to the recruiting centres.

The extent to which the WAAF has now become an integral part of the RAF can be seen from the single fact that the five "trades" originally open to women, mostly of a domestic and clerical kind, have grown to over 50. As the WAAF proved their worth in one job, others were opened to them. Now there are WAAF personnel in a whole group of what may be termed the signals trades—wireless and radio operators, radio mechanics and the like. These crafts, and the allied radio-

A.S.O. Joan Daphne Pearson was awarded George Cross for saving airmen's lives.

Three more WAAF heroines are Sgt. Joan Eugene Mortimer, A. S. O. Elspeth Candlish-Henderson and Sgt. Helen Emily Turner, each awarded the Military Medal for wartime work.

location work, absorb around 50 per cent of present-day airwomen. There are a number of technicians, trained by the RAF in skilled and semi-skilled maintenance jobs—armourers, electricians, flight mechanics, sparking-plug testers and instrument repairers; another group of trades is of a scientific nature, such as meteorologist, photographer, sine-projectionist and tracer; there are such domestic jobs as cook, tailor, hairdresser and batwoman or orderly; a clerical group includes clerks both general and specialist, bomb plotters and equipment assistants; whilst in the medical class are found dental clerks, dispensers, masseuses, radiographers and operating room assistants.

During the first bitter winter of the war, women in the WAAF were tried out on a number of RAF stations. Their life was hard for a variety of reasons, not least of which were hastily adapted accommodation and lack of equipment. Bad weather added to the discomfort, for the coldest winter that England has known for several decades held the country ice and snow-bound for many months.

Owing to the rapid expansion, the only general issue of uniform which was possible at that time consisted of a raincoat, a navy blue beret with the RAF cap badge pinned on the front, service shoes and stockings, undergarments, and an overall to wear over the airwoman's own clothes while she was on duty. But soon the equipment was produced; shirts, collars and ties, a second pair of shoes, a warm fleece lining for the raincoat, and finally—a proud moment—the issue of the first tunic and skirt. By February, 1940, issues were complete for this quickly extending service. In full uniform, the

These WAAF officers are serving in the Middle East with RAF units. They are specialists assigned to code and cypher duties.

airwomen felt that they were no longer civilians in a service —they were part of it.

Slowly, but with increasing confidence in the ability of the airwomen to take over work which had hitherto been regarded as only suitable for men, more trades were opened up for women. Training facilities became available and enlistment

(*Continued on page* 254)

WAAF airwomen, assigned certain maintenance duties, are shown in rear cockpits of Miles "Master" trainers.

THE MAN IN ACTION

by Flight Lieutenant H. E. BATES

Superiority of the RAF over the enemy is due partly to superior aircraft, but largely to its manpower—among the finest in the world.

ON a bright December afternoon a *Stirling* returning from a raid on the docks at Brest came into its aerodrome to land. Its pilot, an Australian, touched down with an exactitude that seemed to indicate that nothing extraordinary was wrong. He was within a day or two of his 23rd birthday. His second pilot, contrary to the popular supposition that the pilots of bombers are for some reason middle-aged men, was a boy of 19. Among the crew was a young engineer, who was badly wounded. The floor of the plane was greasy with oil and blood and from the port outer engine a stream of petrol was pouring out like a bright fan in the wind. As the plane touched down it began to disintegrate. First the port outer propeller fell away; then the whole of the port inner engine. Then the complete port wing fell off and, falling, caught fire. The huge tyres of the *Stirling* were punctured and flat, and finally the whole aircraft tilted violently to port, flinging the starboard wing high into the air. The task of carrying a dying man from a plane which seemed at any moment about to blow up would, in civilian life, have been front page news; complete with pictures, personal interview and possibly framed certificates. Fortunately the plane did not blow up. Half an hour later its crew with the exception of the wounded engineer, now safely in hospital, were having tea, and of that extraordinary episode, and of the earlier episode in which the *Stirling* had beaten off the violent attacks of 10 Messerschmitts, there was nothing in the next morning's newspapers.

In this story and behind it, in ten thousand others of which the public will never see a record because there are so many

A typical man of action is Squadron Leader A. C. Deere, who was shot down three times during fighting at Dunkirk, had a bomb explode beside his plane on an aerodrome, ran into a Messerschmitt in a 700 m.p.h. air collision, then had his own plane cut in two in still another unexpected meeting in the air. Before promotion to present rank, he was presented with the DFC by H. M. King George (below).

Pilots of Westland "Whirlwinds" on "stand by" duty congregate at dispersal hut as they await orders to take their twin-engined single-seater fighters aloft to intercept foe or escort RAF bombers.

of them, there is to be found a fraction of the picture that is being made, every day, every night, over sea and land and in all latitudes, of the men of the RAF in action. The title of these pictures is not heroism, since the RAF, with its vital genius for the rejection of normal speech and the coinage of new, does not know the word. Nor are they ever likely to occupy the place in popular literature and art long held by "The Charge of the Light Brigade." On the contrary they are, and will probably continue to be, taken very much for granted. For since the day when the British made the incredible and ghastly heroic blunder in the Crimea and somehow got it immortalized as a national epic, the standards of heroism, like the standards of speed and science and plain inhumanity, have undergone great changes. They have changed so far that they have, in some cases, ceased to mean anything. This has become very true of flying in general and, within the last three years, of the RAF in particular. One simple result of this is that the work of the RAF, which an earlier age would certainly have immortalized in verse, even if it was bad verse, is today recorded in language as plain, matter-of-fact and perishable as a cardboard box. The work of the RAF—words like deeds, exploits, feats of valour and so on have no place in its vocabulary—lies hidden too often behind colourless communiques and factual broadcasts that we now take as much for granted as the kitchen stove.

For this flatness, the lack of the heroic touch in the history of its action achievement, the RAF is itself partly responsible. The men of the RAF are largely inarticulate; they would prefer anonymity; and perhaps the worst of all sins in the RAF is the process known as "shooting a line." The now immortal father of all line-shooters was a fighter pilot who was heard to declaim, with fine pomposity, in one of those unfortunate silences that sometimes fall on general conversation "There was I, flying upside down." This remark has since become the standard by which any personal flying achievement in the RAF, whether heroic or not, has come to be judged. To shoot a line is now embarrassing, boring, comic, or in plain bad taste. In this way the RAF has elected to speak even of its most exceptional achievements in terms of understatement. To find the pilot who will tell you the story of a combat with simplicity, directness and lack of embarrassment is in consequence a rare thing.

A one-armed fighter pilot commemorates his misfortune with an appropriate insigne on the fuselage of his "Hurricane."

To fly and to be inarticulate, even to pretend to be inarticulate, have become, with rare exceptions, inseparable qualities. To treat the daily association with danger as if it were nothing more than a game of cricket has become almost a rule. Laconic, nonchalant, dry, indifferent, the RAF passes a common verdict even on the most glorious of its moments of action with a couple of words. "Good show," it says. "Good show."

But what the RAF *does* and what the RAF *says* about what it does are necessarily different things. The fact that the

Crews of "Stirling" bombers report details of their raid to Intelligence Officer. Full record is kept of results.

achievements of the RAF have not so far been recorded with outstanding objectivity, force and imagination is due to very simple things. Pilots, for the most part, cannot write; writers, for the most part, cannot fly. The day on which we get a fusion of these qualities in one person we may be given, even though in a limited way, a real picture of the RAF in action. It will be limited not only because one pilot cannot speak for ten thousand but because the fighter pilot differs from the bomber pilot and the bomber pilot in turn from the coastal pilot and all three in turn from the ferry pilot as much as the *Spitfire* from the *Stirling*, the *Hampden* from the *Sunderland*, the *Liberator* from the *Kittyhawk*. These types are not only temperamentally different from each other; their daily life is different; their actions and reactions are different; only their final aim, the destruction of an enemy, is the same. To understand them, to assess the differences in their lives and their performance in action, one must live with them for a long time.

Flying Officer Kenneth Campbell, who received posthumous award of the V.C. for a torpedo attack on Nazi warships.

Of all flying types the fighter pilot is, to the public, the most attractive. The reasons are again simple. His actions are seen as a triumph of individuality; he flies alone in a high-powered piece of mechanism which is capable, in his hands, of evolutions at great speed, of great beauty and spectacular effect. He is engaged in a dangerous, apparently wonderful and often fatal occupation. Like the bull-fighter, he works near to and often in line with death. To the public this near-fatal occupation, whether of bull-fighters, tight-rope walkers or fighter pilots, is fascinating to contemplate. For of all pilots the fighter pilot is most likely to be seen —and during the Battle of Britain was constantly seen—in action. The coastal pilot is invisible, far out at sea; the bomber pilot is invisible, far out in darkness. The *Spitfire* pilot flies in the sun, turning his plane like a silver fish many thousand feet up, and fascinates the world below.

This is one part of the picture; the finished, pleasant, spectacular part, seen by the public. There are two others. One is the daily and almost certainly boring routine of the aerodrome and the dispersal point, which the public never sees; the other is that of the action itself—which the public also rarely sees and which the combatant will rarely discuss, the action involving emotions, reactions and tension, for which the public has no remotely comparable experience of its own. The picture of life on the aerodrome is simple. On duty throughout all the daylight hours—as few as eight in winter, as many as 18 in summer—the fighter pilot's problem is often not how to kill Germans but how to kill time. His life, while waiting for action, may be intensely boring, dull, directionless. To counteract these things he reads, plays cards, revises navigation, talks shop. His action, even when it comes, is packed into a hundred minutes, of which perhaps 10 or 15 form the vortex in which he destroys or is destroyed.

From the thousands of stories by the fighters in action it is not possible to select one which will typify the fighter pilot. It is simpler to select a man who has crowded into one life the experience of 20 pilots and to record of him simply—"This is not typical. It belongs to the highest and rarest achievement. But it happened."

Of all fighter pilots Squadron Leader A. C. Deere, D.F.C. and bar, is probably least typical. He was born in New Zealand; joined the RAF in 1937; won service boxing championships; played football. In four months of the summer of 1940, from May to August, he destroyed 17 enemy planes. He was shot down seven times; baled out three times. He collided head-on with an enemy machine; a pupil pilot cut his *Spitfire* in two. One plane of his was once blown 150 yards along the ground by a bomb; another blew up three seconds after he left it.

His action began in May, 1940. He had volunteered, with another pilot, to escort a small training-type aircraft to Marck, the aerodrome at Calais. He was to land there and pick up a squadron leader who had forced-landed. The Battle of France was in progress; Calais was surrounded by the enemy; the aerodrome was a kind of "No-man's land." When the trainer landed, the passenger was nowhere to be seen. After waiting a few moments the trainer took off again and was just airborne when a dozen Me. 109's attacked the escort planes. The trainer, forced back to land, hit a hedge. Then followed what Deere himself has described as "a grand shooting match with the Me.'s"—the words are typical—leaving Deere and his fellow pilot still flying and the wrecks of Messerschmitts lying all about the beach, the aerodrome and the town. The action seems to have been a fine example of the gay ferocity for which fighter-pilots have become famous: Deere claimed two certainly destroyed and one probable, his companion one certainty and two probables. The pilot of the trainer got away.

From that moment Deere seems to have had no rest. His patrols over the coast of France began at 3:45 a.m.; often he

Bombing raids involving 1,000 or more aircraft are being carried out by the RAF with telling results. Here a crew is preparing for a "night out."

made two before breakfast. In a few days his squadron lost six pilots; and soon Deere, although only a pilot-officer, had become its leader. His adventures began to be fantastic. When he pursued a Dornier from Dunkirk to Ostend and both the Dornier and his own machine crash-landed, Deere was knocked out and his machine began to burn. As he scrambled clear, half conscious, his machine exploded. Two days later he collided with an Me-109 in mid-air. Each pilot seems to have thought that the other would give way. They passed each other once, turned and came together again. Deere lost a little height in the second turn and the belly of the Me tore along the fuselage of his plane, running the hood down on his head. The propeller was snapped off by this impact and the engine partially torn out. Deere, blinded by smoke and flames, could see nothing and could only hold the plane in a 100 m.p.h. glide which took him gradually over the English coast. There his craft hit a concrete anti-invasion post, ripped off a wing, skidded through two cornfields and finally burnt up.

A week or two later he chased a Heinkel over the Channel towards Calais. Shooting down the Heinkel, he was immediately "jumped on by a swarm of other fighters." A bullet ripped the watch from his wrist; another scorched an eyebrow. His aircraft was full of holes, and over Ashford, 20 miles inland and at 800 feet, it began to fall to pieces. Those were the days when shoppers in that market town in the heart of the Kentish sheep and hop and orchard country would look up 20 times a day—I myself among them—and watch the battles in the blue summer air. They must have watched with horror that day as Deere baled out of his disintegrating plane, his parachute not opening until he was perilously close to the earth. Yet Deere was flying again next day.

Two days later he had his oil tank shot away and had to force-land without his air speed indicator; soon afterwards his rudder was shot away and his engine set on fire. He bailed out again and landed in a plum-tree. Next morning his aerodrome was dive-bombed. A bomb fell immediately in front of him as he sat in his plane, blew the engine of the *Spitfire* out and sent the plane itself hurtling upside down with Deere in it, for 150 yards. He was helped out by a fellow pilot and ran for shelter. Afterwards he was put to bed and was still in bed, next day, when another raid began. He got up from his bed immediately, went up in his *Spitfire* and shot down a Dornier.

Shortly afterwards he was teaching tactics to a pupil. Something went wrong; the pupil collided with the teacher, cutting the *Spitfire* in half. Deere was caught in the wreckage of his plane and could not jump. The plane fell for several thousand feet before he could get clear. Half of his parachute harness had been torn off; the rip cord dangled out of his reach. Deere closed his eyes and waited, knowing there was nothing he could do. Suddenly his shoulders were violently

This "Wellington" caught fire during battle, was saved when rear gunner (left) beat out flames with parachute.

jerked by the parachute opening of its own accord. That day Deere was in hospital for the third time.

A large part of these adventures cannot be called heroic; they are examples of fantastic misfortunes which may and do happen to any pilot, any day, anywhere. Deere's career is remarkable because he brings to such a succession of events, any one of which might have been his death, an indomitable stoicism; the spirit of apparently careless fatalism which is an important part of the fighter pilot's make-up. Above all he brings to them, as almost every pilot does, a passion for flying. This passion, which in the lives of young pilots who have often known no other life than flying is a dominant quality, is well illustrated by the experience of a *Hurricane* pilot, Sq. Ldr. J. A. F. MacLachlan, D.F.C. and bar. MacLachlan is a young, exuberant, magnificent personality. In France he shot down six dive bombers in four days; over Malta he destroyed several Italians. He himself was finally shot down over Malta by an Me-109: a type for which the *Hurricane* of that day was far too slow. In that action MacLachlan lost his left arm and spent most of his time in hospital not only in an agony of physical pain but in an agony of mental pain—the agony simply of fearing he would never fly again. Yet in 15 days from the time his arm was amputated MacLachlan was flying solo again; an enterprise most people would have been extremely chary of undertaking in 15 weeks. His joy at being able to fly again was precisely the joy of the ordinary man at being alive at all: not to have flown would have been synonymous, for him, with not being alive. Today MacLachlan flies with great skill, daring and success as a night-fighter, using a specially constructed intricate artificial arm in place of the arm he lost. He is an exceptional example of the fighter pilot in action: of the supreme individualism which even such physical disability as the loss of an arm (in the case of the famous Bader the loss of both legs) will not crush. It is this individualism, enabling them to undertake extreme risks because they know that failure can affect no one but themselves, that set fighter pilots apart from all the rest.

This individualism is not dominant, on the other hand, in the pilots of bombers and coastal aircraft. In planes carrying crews the attitude of the pilot is very different from that of the pilot flying alone; his position becomes much more like that of the captain of a ship. His word is, in fact, law; he is in absolute command. He must also not only think of the safety of others; he

(*Continued on page* 223)

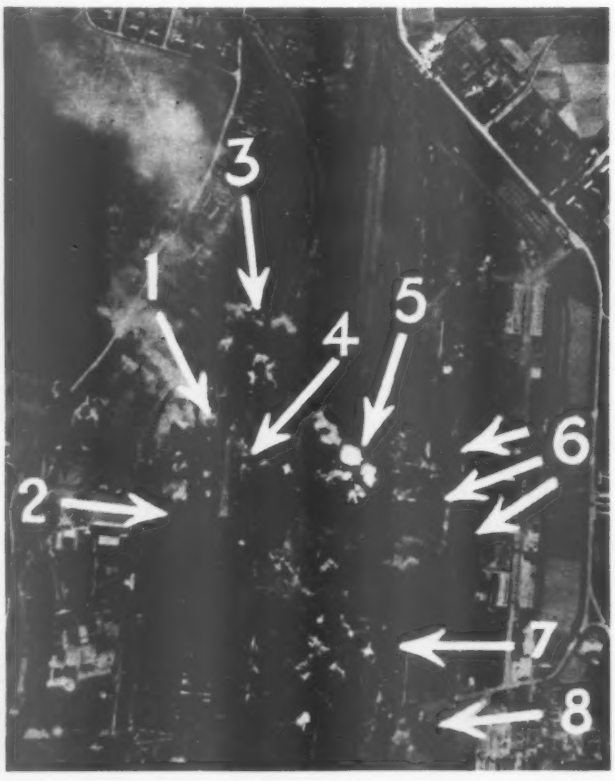
Equipped with "Mae Wests" for possible ducking in the English Channel, pilots of Fighter Command study the target of impending daylight sweep.

PHOTOGRAPHY

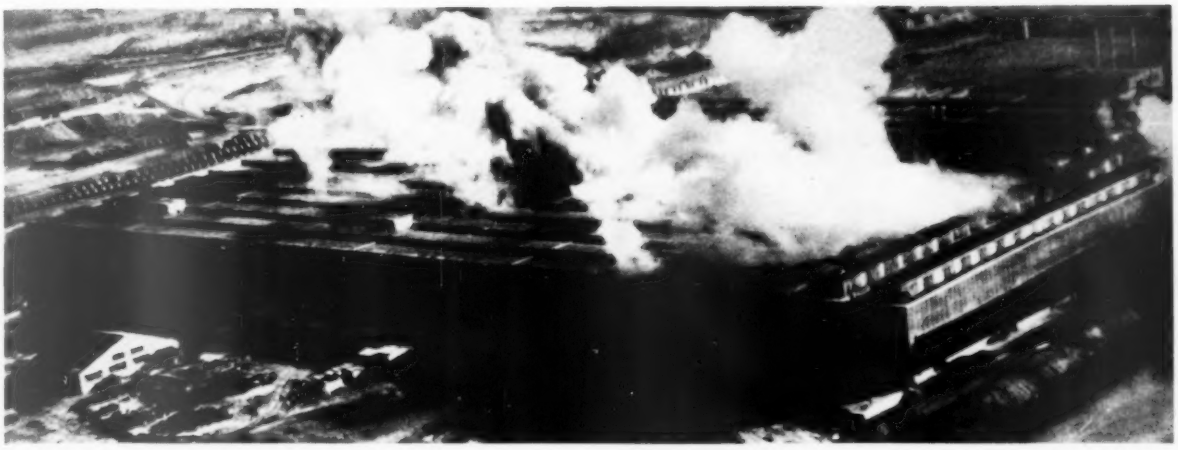
by

GROUP CAPT. F. C. V. LAWS, O.B.E., DEPUTY DIRECTOR OF PHOTOGRAPHY, has been closely associated with service air photography since it was introduced into the Royal Flying Corps in 1912. Many important developments may be traced to his efforts.

This is the flying camera at work. Positive information brought back from this raid on a power station and chemical works in France show falling bombs (top left) and following damage: 1, hit on southwest boiler house; 2, hit on northeast boilers; 3, hits on train on siding; 4, hit dynamo house; 5, workshops; 6, chemical works: 7, pipeline; 8, incendiaries burning near tank.



Every modern military operation depends largely on photographs. The camera is one of the most potent weapons of this war.



Using a mirror attachment, an RAF camera records a daylight attack on the Matford works at Poissy, Paris. Notice that unrefutable proof has been obtained of direct hits on target.

THE aim of air photography in war is to obtain accurate information and to present it as clearly and quickly as possible.

Ministers, admirals, generals, and air marshals anxiously await photographs that will tell of the enemy's movements and which will enable plans to be made for his destruction.

Day by day and night by night the work goes on, for cameras are the untiring eyes of fighter and bomber alike; theirs is the eagle's view from 40,000 feet—or perhaps that of the seagull, skimming the mast head to bear witness to another enemy cargo sent to the bottom.

Great numbers of photographs are brought back from flights, and when systematically "interpreted" by experts are the most important source of information about the enemy's activities. Though a single photograph may show an accumulation of tanks in a village, the progress of a shipbuilding yard or fortification must be followed by a carefully planned series of photographs extending over weeks or even months, and taken often in the face of adverse weather conditions and enemy opposition.

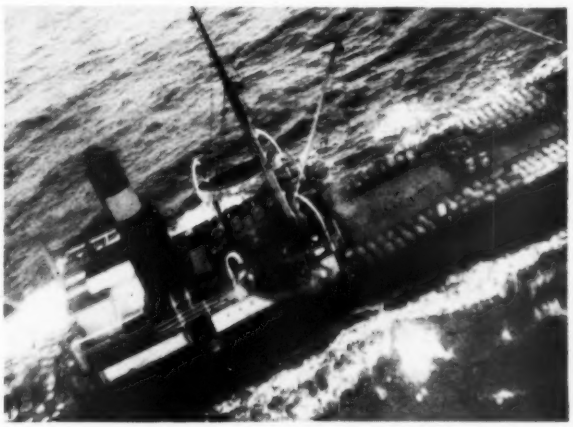
Photography plays a large part on every front, and behind the vast but little noticed organisation that makes this possible lies a long story of progress and endeavour.

Air photography is already a veteran, having given much good service in the war of 1914-1918. The first air photographs were taken by observers who used ordinary cameras and leant over the side of their open aircraft to get records of the enemy ground dispositions in trench warfare. The development of special air cameras was slow at first, but once the possibilities were recognised the effort was intensified until at length the F-24 was produced by the RAF. This was an efficient and reliable instrument at the outbreak of the present world war.

In the development of this camera attention had been paid to the prime necessity of automatic operation and control, so that series of photographs could be taken at predetermined intervals and large areas covered with the greatest accuracy. Thus from the beginning of the present war we had a sufficient number of suitable cameras, and could start immediately on the reconnaissance of enemy territory.

However, the requirements of modern warfare are legion, and the "straight" F-24 reconnaissance camera soon became merely the foundation upon which most of the later developments were based. The constant call for improvements soon proved how right the experts had been when they designed the F-24 on a "unit" system!—each section self-contained and easily interchangeable. Thus if a large capacity magazine were required for special reconnaissance, only the magazine had to be built; or if a faster shutter was needed, then only the shutter blind had to be replaced. The first question asked when a new type of photography is required is how can the F-24 be adapted?

Apart from the production of equipment there has been the

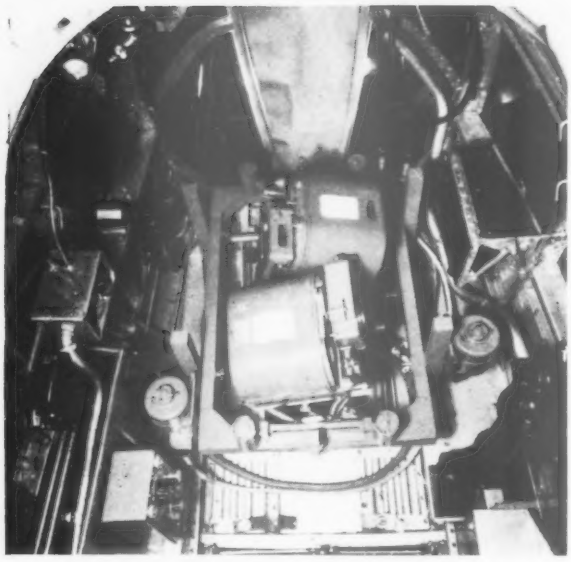


An F-24 camera with a mirror attachment was used to take this photograph at 75 feet of an attack on an enemy ship.

equally important problem of recruiting and training of RAF photographers. Fortunately the RAF found a ready response to the call for recruits. Amongst those who joined were many skilled amateurs and not a few professionals of lifelong experience. Aided by the specialised training of the RAF schools of photography their knowledge has proved invaluable, for it is only by the skill and experience of trained men that the new equipment can be maintained and used to the best advantage. Members of the WAAF are proving very successful in photographic work.

The uses of air photography in war are legion; we can describe only a few of the more important.

Bomber Command is concerned with locating the target and recording the actual attack, so that success may be established beyond doubt. Since vast areas are covered, the checking of targets is a colossal task, but it must be carefully carried out so that the crews may be shown, before they leave the ground, exactly what the target looks like, even when highly camouflaged. Photography is also a regular part of the bombing routine. The camera, automatically operated by the bomb release switch, takes a complete run of photographs of the whole bombing operation. Photography is not restricted to day bombing only, for by the aid of a powerful flash bomb and the



This is a typical installation of "split" F-24 cameras, mounted obliquely to cover twice the area that normally can be seen.

ever adaptable F.24, the results of our night attacks can often be checked in every detail. We know where every aircraft dropped its bombs, and in many cases we can spot the actual bomb bursts. It is rarely possible, however, to get sufficient detail in a night photograph for actual damage assessment; this must be left to the reconnaissance aircraft which will follow up next day. The information obtained enables the Air Ministry to issue a bulletin like this: "Severe damage to the biggest assembly shop of the Heinkel Aircraft Works is revealed by the latest picture taken of Rostock after its four nights of sustained attack by the RAF."

In daylight reconnaissance, Coastal Command may need photographs to identify and locate the positions of enemy shipping. The navigator is considerably aided in this work by still another adaptation of the F.24. A "while-you-wait" developing unit is built into his camera and he can get a picture of the target within two minutes of making an exposure.

Bomber and Coastal Commands also require records of low level bombing attacks, sometimes not more than 50 feet from the ground. From this height a vertical shot, even with a wide angle lens, would cover only a very small area, and the great speed of the aircraft would result in a very blurred picture such as you see from a fast moving train when another and equally fast one is going the other way. The difficulty has been overcome by attaching a mirror to the lens. This mirror is set at 45° to the lens axis, and when directed backwards under the tail of the aircraft, will secure a picture of the target that has just been attacked.

The photographers of the RAF are located in various parts of the war zones. Their jobs may range from a single photograph of a railway siding to a thousand photographs mapping an entirely uncharted territory. Their headquarters may be either a train of mobile dark rooms in the field or a specially planned building at the home base.

The camera equipment ranges from F.24's with 3¼ inch lens and 5 inch by 5 inch negative to F.8's and F.52's with their special 40 inch telephotos covering negatives 8½ inches by 7 inches. In peace time, air survey could be carried out in an orderly and leisurely manner by floating up and down the area to be surveyed at heights such as 5,000 feet and speeds of some 120 m.p.h. But such risks can hardly be taken in wartime and flying speeds are more likely to be in the neighbourhood of 300 m.p.h. As for the ceiling, it has been raised to nearly 40,000 feet, and it is from these great altitudes that the long focus lenses are used to produce photographs of the necessary scale.

At these great heights our aircraft penetrate far into enemy territory, where they photograph whole districts in broad daylight, remaining invisible to the enemy so long as they avoid those particular altitudes where the tell-tale condensation trail will give them away.

Reconnaissance photography is carried out on such a large scale that hand processing and printing is impracticable. Only automatic machines are capable of handling the hundreds of negatives and thousands of prints that are required every day. In fact the processing unit is not unlike that of a motion picture laboratory. It handles great lengths of film, and the latest sensitometric methods are used to ensure results of the highest possible quality.

The Army also has co-operation reconnaissance personnel who are the eyes of the Army in warfare and are always on the watch for enemy movements. Speed is of vital importance if the best use is to be made of this information, and special processing sections are pushed up as closely as possible to the actual front line. Magazines are dropped by parachute to avoid landing delay, and a special rapid processing equipment is installed—so that the Interpretation Officer may get prints within 10 minutes of the magazine arriving in the processing section. This special processing is done in a spiral type processing tank, and the technique involves the use of highly concentrated solutions, which give adequate development in 1¼ minutes. The negatives are printed wet on specially prepared paper.

Perhaps one of the most interesting applications of photography in the RAF is the use of the cine-camera gun for recording actual aerial combat and for training fighter pilots. When used in actual combat these cameras provide incontestable proof of enemy aircraft being shot to pieces, and many extracts have been included as "highlights" in films for release to the public.

The cine-camera gun uses 16 mm. film, and is mounted in the aircraft as a "fixed" or "free" gun, to be used in addition to the other guns when in action, or in place of an actual gun during practice. It is automatically started with the depression of the gun-firing switch and "shoots" a series of pictures of the target plane which serve to record its position relative to the attacker. It has largely replaced the "towed target" as a means of training fighter pilots since it provides not only much more realistic combat conditions, but also makes a record of the "near misses."

Staffed by WAAF photographers, this trailer is a complete developing and printing unit, complete with air conditioning.

It has been stated that RAF aircraft cameras are built on a unit system which readily lends itself to modification for special types of photography and ensures freedom for maintenance and repair. Some idea of how the system works may be gained by taking the F.24 camera as an example. The basic camera is built up of six units:

1. *The body.* This houses the shutter and to it are attached the other units.

2. *The focal plane shutter.* The three interchangeable blinds have different slit widths and variable tensions, giving a range of exposure from 1/100th-1/1,000 second.

3. *The gearbox.* This contains the mechanism for releasing the shutter, winding on the film and resetting the shutter—an operation which takes just over a second.

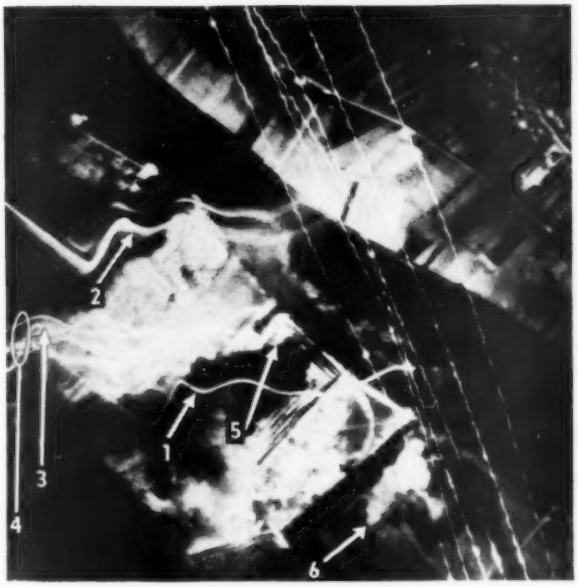
4. *The lens and cone.* Five types of lens are employed, ranging from the 3¼ inch f/5.6 extra wide angle lens to the 20-inch f/5.6 telephoto. (The standard cone contains the eight-inch f/2.9 lens.).

5. *The magazine.* The two types supplied are of 125 and 250 exposure capacity. The camera gives a negative five inches square.

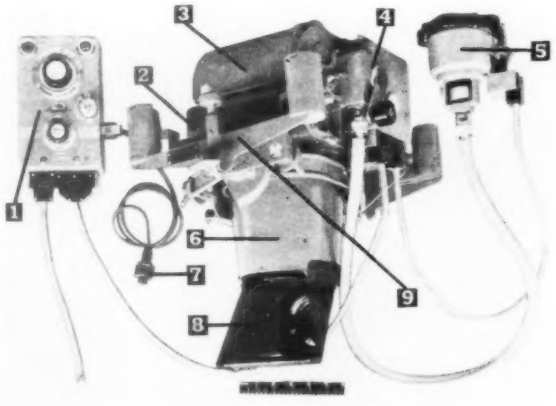
6. *Camera mounting.* This is specially designed to allow the camera to be levelled in the air and kept free from vibration of the aircraft.

The Universal night camera is an adapted F.24 fitted with an exposing blind of special type—that is, with a width of slit equal to the negative size, thus permitting a "time" exposure. An unexposed section of film will be brought into position over the lens, and will remain exposed until the control winds it over again. This control is a special "Type 35" which is pre-set to expose a fresh section of film five seconds before the flash is due to explode, and to wind on this section five seconds after the explosion has taken place. The exposures obtained in this way will show a certain degree of movement, and also traces of fires on the ground, searchlights and antiaircraft fire. However, as night raids are usually carried out from great heights, the advantage gained by using the whole of the flash will compensate for the disadvantages entailed, and prints may be obtained which are not sufficiently sharp to permit the location of the aircraft at the moment of exposure, but which also show the exact location of the bomb bursts.

Many night operations take place at comparatively low levels, at which a faster exposure is necessary. For such cases the F.24 has been further modified as the F.24 Mark 1A, in which a built-in Louvre shutter is actuated by a photo-electric attachment on the side of the cone. The shutter is opened by the control five seconds before the flash is due to explode, and is closed at the "peak" of the flash by the photo-electric attachment. This "peak" is reached in 1/60th second, but most of the light has already done its work and will produce an image sufficiently sharp for ship recognition at heights up to nearly 10,000 feet.



This picture of a night raid on the Matford works was made by flash bomb and open plate. 1, 2 and 3 are tracks of fires burning on the target; 4, muzzle flame and tracer from an antiaircraft gun; 5, searchlight track; 6, exploding bomb.



An F-24 camera fitted with a 45° mirror attachment and accessories. The numbered parts are as follows:

1. T-35 control, modified to give two-second intervals.
2. Body of the camera.
3. Magazine containing 125 exposures.
4. Gearbox.
5. Driving motor.
6. Eight-inch lens and cone.
7. Operating switch.
8. Mirror attachment.
9. Type 25 camera mounting.

In certain cases it is necessary to get results "on the spot" so that "position" or some particular target may be identified before leaving the area. In this case it is true in the strictly literal sense that the experts have "provided the solution"—for they have designed a special processing unit which can be incorporated in the camera magazine.

The magazine so modified is the larger 250 exposure type in which much of the space normally occupied by the large roll of film is occupied by two stainless steel tanks containing jellied processing solutions. A short length of film is loaded into a light tight cassette and threaded through the magazine for exposure in the normal manner. The film is then fed on to a slow speed sprocket system which takes it through the processing tanks, through a squeegee and out through the case of the magazine, which is fitted with a guillotine cutter. A developed and stabilized negative is fed out of the camera in approximately *two minutes* from the time of exposure.

These, then, are some of the requirements of operational air photography in the RAF. The less spectacular but equally important aspect is the business of camera installation and maintenance, and the processing and printing of the films. Cameras have to work for long hours under the most severe conditions and even the slightest unchecked fault may ruin a whole reconnaissance.

This is where the RAF photographer comes in. Aircraft cameras are installed and adjusted to work on the "Robot" principle. When the pilot or bomb aimer presses a button the rest can be safely left to "T.35"—that ingenious control, which can start a whole series of operations—from a 500 exposure reconnaissance requiring exposures at regular intervals, to the synchronisation of the flash explosion with the actual bomb bursts during the night raid.

Most people who have used a camera will know how important it is to estimate the right exposure. This again is a job for the photographer, who must calculate and "set" the exposure before the aircraft leaves the ground, for it is generally impossible to make alterations in flight. The problem of estimating exposures is much more difficult in aerial photography than in ground work. These exposure problems do not arise to any great extent from the type of subject or from the weather, for at high altitudes the weather is very much the same the world over and all subjects are alike. The chief problem lies in the fact that the exposures are usually made

(*Continued on page 272*)

SIGNALS and RADIO

The secret RAF method of applying radio-location to the interception of aircraft proved a surprise weapon fatal to Nazis.

by Charles W. Nutting

AIR VICE MARSHAL C. W. NUTTING, C.B.E., D.S.C., DIRECTOR OF SIGNALS, received his early technical training at Bromley School of Science and Art and the British School of Telegraphy. In the first World War he served as a gunner in the 2nd Kent Royal Garrison Artillery, then, in 1915, received a commission in the Royal Naval Volunteer Reserve. He served in France with a Wing of the Royal Naval Air Service and was awarded the D. S. C. After receiving his commission in the RAF he served in Egypt, India and Iraq, and in the Signals Branch, Air Ministry. He became Director of Signals in 1937.

"CRACK off a signal." The first time he hears these crisp and incisive words the newcomer to the RAF may wonder how it's done. But the RAF Signals Organisation is crisp and efficient too and the signal is sent quickly, surely and with the utmost secrecy, to the ends of the earth and all points in between. This is accepted as a matter of course. Much besides is demanded from a signals organisation by modern war.

It was not until long after the Battle of Britain had been fought and won, and the cream of the Luftwaffe thoroughly skimmed by the RAF, that something of the secret of that magnificent success was revealed. One day, newspaper readers and radio listeners found a new word added to their vocabulary —radiolocation. Here, in a tersely descriptive word, was the key which had so largely succeeded in locking the gates of Britain against the grim battering of the Nazi air force.

Today a large proportion of the total signals effort is applied to the use, development and extension of radiolocation. The precise methods of applying radiolocation to the interception of aircraft must of necessity remain highly secret, but the principle that reflected radio energy can be measured to determine the whereabouts of the reflecting object has been generally known for some time. Any object, be it aircraft, a ship or even a human body, in which the speed of radio waves is different from their normal speed in space, will reflect a proportion of the energy which strikes it. Nothing is invisible to radiolocation unless it can completely absorb radio energy or pass it on without any reflection and the range at which aircraft can be detected makes it possible to deploy fighters before the enemy is near enough to his objective to carry out an undisturbed attack.

Ground crew technicians of the RAF Signals organisation testing a Hawker "Hurricane" fighter's radio equipment.

What this means in economy of effort is illustrated by the Battle of Britain, in which comparatively few fighter pilots, equipped with efficient machines, were able to shoot literally hundreds of enemy aircraft out of the sky. Radiolocation tells us that a raid is developing in a certain area. This information is signalled to a plotting room at headquarters. There it is co-ordinated with signals from other stations, so that the general situation is under constant review. Further instructions are signalled to a fighter group which, in turn, tells its stations to fly off the necessary planes to the point where it appears that successful interception can be effected.

Once they are off the ground, the fighter pilots are kept informed by radio of the subsequent movements of the enemy. In the air, fighter pilots can talk to each other, giving warning by radio of any danger they may see or encouraging one another in a tough spot. If the action is over the sea and aircraft, friend and foe, have fallen into the water, then radiolocation and a radio call from a pilot still on the spot enable the ground organisation to pin-point a position, and bring the Air/Sea Rescue Service into action.

But, important (and romantic) though it is, radiolocation is only one of the many aspects of the "Signals" organisation. No operation, however small, is ever planned without due consideration of signal requirements. The central organisation and planning of signals in the RAF is the responsibility of an Air Ministry directorate which is part of the department of the Chief of the Air Staff. The staff of the Director General and Inspector of Signals keep intimately in touch with operational requirements and the application of signals technique to plans for future operations. They are a team of skilled technical officers, each with practical experience in the particular subject in which he specialises, and their range of specialisation covers a very wide field.

Not until the full story of the war can be written will the dramatic part played by Signals be completely revealed, but some of the problems which have to be faced may be discussed here.

Modern aircraft move at terrific speed; the handling of signals concerning them must be equally rapid in action. The technical ability to transmit a message through the ether at some 186,000 miles per second is of little value if the information thus despatched cannot be handled promptly. Hence the signal problems of the world-wide organisation of the RAF divide themselves naturally into the technical and supply problems of designing and fitting up the equipment, and the prob-

lems of handling the traffic. To carry out these many functions the three most important needs are materials, men and comprehensive planning.

What are the materials of the RAF Signals Organisation? The methods employed are radio transmitters and receivers, telephone and teleprinter circuits, visual signalling apparatus, despatch riders, special carriers and pigeons. The catalogue of equipment maintained by the stores organisation to supply these needs is an inches-thick book, having some 25,000 separate entries—apart from the large number of items of electrical equipment and general purpose tools which are necessary for signal equipment engineering. The total test is prodigious. To take thermionic valves alone—there are hundreds of types of these, used for thousands of purposes, and service needs are in the region of tens of millions a year.

The thermionic valve and its many applications is perhaps the key to the rapid expansion in the signals of the RAF. It is a far cry from that day in 1912, when communication by means of crude spark apparatus was first established between the Grahame White hangar at Hendon and an aircraft circling the aerodrome, to the modern fighter control organisation. Today the pilot of an aircraft moving at 400 m.p.h. talks to his ground station as easily as if he were using the telephone from the next office.

In the transmission of information it may be necessary for two people to speak together, or alternatively the need for a permanent record may involve the production of a written message. In the first case either a landline or a radio link may be provided between the two officers concerned. The link must be of high quality to enable what is being said at either end to be heard at the other wthout any loss of clarity. In the second case too, either landline or radio links may be used, but the rendering of a message in a written form makes it necessary to use the morse code or teleprinter systems of transmission. Each of the systems has its advantages, and many considerations can affect the choice of one or the other. For example, shall it be a landline or a radio link? If one end of the channel has to be mobile, an aircraft, for example, then obviously a radio link is essential. Moreover, radio links enable a message to be sent to several distant points at once and can usually be provided at shorter notice than can landlines. But between two fixed points, if landlines exist it is probably better to use them. The landline channel is less susceptible to interference than a radio link. It is also more private, but is, of course, more liable to damage by enemy action. Similarly, shall we use morse or teleprinter transmission? Provided the apparatus is available at the two points to be brought into contact, the teleprinter system is capable of more rapid transmission than morse and involves the employment of less highly skilled operators. With a very short period of training a typist with no technical knowledge can achieve a speed of some 35 to 40 words a minute on the teleprinter. This enables teleprinter operators to be widely recruited and quickly trained.

So widespread has the use of teleprinter technique become in air operational organisation in Great Britain that the RAF network linking up the many installations today is a good deal larger than the whole Public Telegraph Service operated by the General Post Office. To provision and maintain it the RAF, in addition to its own organisation, has to call on the vast resources of the GPO. One outstanding example of the system's usefulness is the simultaneous broadcast of meteorological information which is vital to the planning of aircraft movements.

For speech purposes, too, there exists an extensive network of private wires exclusive to the RAF. A large percentage of these circuits are devoted to operational purposes and carry the speech traffic for the air raid reporting system and the operational control of Bomber, Fighter and Coastal Command aircraft. Parallel with these speech circuits there exists an administration network which links units of the maintenance, supply and training organisations as well as those of the operational commands.

Spread about the country at a number of key points are several major signals centres at which most of the switching for these networks is done. These are the very nerve centres of the RAF in Great Britain. The equipment is housed in underground buildings, and elaborate precautions are taken against the possibility of their being damaged. The apparatus used is of the most modern type, including telephone working over co-axial cables in which 400 speech circuits are

Fixed, transportable and mobile radio stations are used in the work of Signals. Here a mobile unit transmits a message.

Standing at the navigator's table, a pilot officer, captain of this Short "Sunderland," 'phones orders to crew members.

Wireless operator of a Lockheed "Hudson" reports to Coastal Command after successful conclusion of encounter with enemy.

The wireless operator uses an Aldis lamp to signal the other "Lockheeds" in his formation to "close in" for return flight.

A member of the Women's Auxiliary Air Force transmits a message for Coastal Command. Many WAAF are in Signals.

worked over one wire, a system which is not only most economical but also permits damaged cables to be repaired in a very short time. "High frequency speech carrier" working over cables and open wires, and voice frequency telegraphy are also widely used.

Radio communication within the RAF is organised on a world-wide basis. High speed automatic links connect overseas commands to one another and to Air Ministry. Within each command arrangements exist for every unit to maintain communication with its group headquarters and for group headquarters to keep in touch with command headquarters.

This system involves the maintenance and operation of a large number of wireless-telegraph and radio-telephone stations, which are either fixed, transportable or completely mobile. According to the particular type of communication desired, any one of a large number of equipment designs may be used. The system calls, too, for the operation of a comprehensive system of coding so that security may be preserved and standard phrases transmitted with the least possible effort.

Both radio telephony and wireless telegraphy are also used for communication between ground stations and aircraft. The equipment for any particular aircraft and the procedure observed depends, of course, on the particular role the aircraft is filling. Generally, for fighters radio telephony is employed, whereas with bomber and general reconnaissance aircraft, wireless telegraphy is used as well as radio telephony.

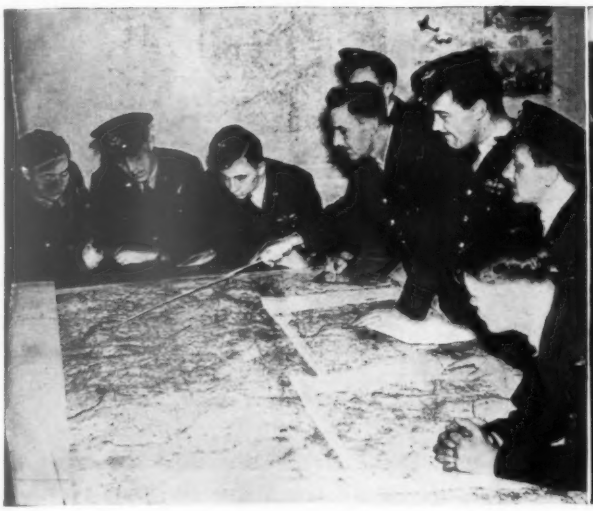
Much ingenuity has gone into the development and installation of the equipment in aircraft. Constant research increases its efficiency, and new materials and manufacturing methods are applied to the various problems as soon as it is seen that they can enable the same high standard of performance to be obtained from lighter equipment or for a smaller power consumption. Simplification of design, ease of operation in the air, reliability, the facility with which repairs can be effected under service conditions—as well as such factors as resistance to corrosion, or to electrical discharge phenomena at high altitudes, are all matters which must be considered when new equipment is being designed.

While, therefore, signals is not an active fighting job, it is vital to the operational efficiency of the service, and officers and other ranks, both RAF and WAAF perform their varied functions with this in mind. Under extreme conditions, such as concentrated enemy attack on their station, they realise they must carry on without the stimulus of active combat with the enemy, and they have never failed to do so. The spirit of service and technical efficiency which pervaded the more compact pre-war organisation has had a profound influence on all the newcomers and all ranks are fully conscious of the great responsibilities they carry and the fine traditions they uphold.

From all walks of life they have come to take their place in this rapidly expanding branch of the RAF. Among them are found many keen radio amateurs of pre-war days, and many of the ether friendships of those days are today being cemented in service messes all over the world.

END

A Royal Air Force pilot, dressed for upper air operations, prepares message for transmission from this camouflaged and sheltered wireless control station located in the Middle East.



The intelligence officer (with pointer) gives last minute information to a bomber crew before a raid on the enemy.

Returned from a raid on Berlin, members of a bomber crew tell their stories in great detail to an intelligence officer.

AIR INTELLIGENCE

by Ex Medhurst.

Every scrap of information obtainable passes through Air Intelligence. These men all but run the RAF side of the war behind the scenes.

THE Encyclopaedia Britannica (says Aldous Huxley) classified "Intelligence" as either animal, human or military. The thrust is a shrewd one, but probably less deserved than our critics think; for military—or for that matter air intelligence—which sounds so mysterious when you call it "M.I.5" or "A.I.6," is in fact extremely human, being nothing more nor less than applied common sense. Flashes of inspiration come at times, and great things are done on the strength of them, but the day-to-day job which the intelligence officer performs is largely the patient accumulation of facts (or of what he hopes are facts) and their subjection to an even more patient scrutiny.

Beautiful spies do not steal the plans of secret submarines from infatuated young attaches; nor do devoted agents stagger across frontiers with the specifications of a new stratosphere bomber embedded in their hollow teeth. Such things may have happened—war is so strange a business that few fiction writers can compete with the oddness of some of its realities; but the truth for the most part is very different. It is hard, grinding work at the desk, with endless disappointment and continual uncertainty; and always, to drive you on, the chance of some secret but none the less tremendous victory.

Heroes of fiction always seem to bring off their triumphs single-handed. The story may start with a torn scrap of paper, but it is always a complete set of plans which is handed over in the last chapter. In real life it is only the torn scraps which come to the intelligence officer's hands. But they are rarely even scraps of paper; it is not stolen documents which fill the files, but brief reports of glances into banned areas, small oddnesses noted, careless words overheard. From such

(*Continued on page* 196)

AIR VICE MARSHAL CHARLES E. H. MEDHURST, C.B., O.B.E., M.C., is Assistant Chief of the Air Staff (Intelligence) and has been since 1941. Son of a minister, Air Vice Marshal Medhurst joined the Royal Inniskilling Fusiliers in 1915, then was seconded to the R.F.C. He resigned his Army commission on appointment to the RAF in 1919. During the last war he was awarded the Military Cross for bombing enemy batteries. He has served in France, Palestine, Iraq, and was Air Attache to Athens, Rome and Berne in 1937. Educated at Rossall, St. Peters (York) and Sandhurst, he was an instructor at the RAF Staff College.

Intelligence officers make careful studies of photographs, comparing them with maps for latest information on enemy.

Six different parts of the British Empire, in addition to the United States, are represented in these shoulder-flashes.

DOMINIONS SQUADRONS

Personnel from every corner of the British Empire are to be found in the RAF. Each dominion has fully-staffed squadrons.

IN September, 1939, the Dominions of the Commonwealth of Nations sprang to arms at the side of Britain. Many of their citizens were already there. Throughout the summer of that year, and in earlier years, men from the Dominions and Colonies had come to England to join the expanding Royal Air Force as aircrews.

As early as 1935, a man, afterwards a squadron commander in the Royal New Zealand Air Force, had worked his passage to England as a ship's writer at a shilling a day to join the RAF. In July, 1939, the Royal Australian Air Force had sent experienced crews to ferry back Short *Sunderland* flying boats from Britain to Australia. Instead, they remained in Britain to take their valiant part in the Battle of the Atlantic. The arrival of the first squadron of the Royal Canadian Air Force in Britain in February, 1940, was preceded by hundreds of Canadians who were by then veteran members of the RAF.

These young men who made their personal choice about the war typify the spirit of the RAF. It is the spirit of free peoples making a free decision.

In peacetime the strength of the Royal Canadian Air Force was about 2,500 men; today its strength is about 100,000 and it has already more than 20 fully operational squadrons of its own in Great Britain alone. Great numbers of Canadians are also serving in every type of squadron in the RAF and in practically all its major operations aircraft manned by Canadian pilots and observers and tended by Canadian ground crews take part.

Air Vice-Marshal H. Edwards, Air Officer-in-Chief of the R.C.A.F. in Great Britain.

The first All-Canadian squadron of the RAF was a fighter squadron formed early in 1940, just as the first squadron of the RCAF, an Army co-operation squadron, arrived in England under Squadron Leader (now Wing Commander) McCryer, D.F.C. Then the Canadians really went into action and in the few weeks of the Battle of Britain, destroyed between them no less than 150 enemy aircraft.

Since that time many more fighter and bomber squadrons of the RCAF have been formed. Canadians have fought over France and the Bay of Bengal; over the North Sea and the Mediterranean; over Colombo and Libya; over Malta and Brest; over Lubeck and Cologne. They have flown *Spitfires* and *Hurricanes, Hampdens* and *Halifaxes, Hudsons* and *Bostons, Wellingtons* and *Stirlings*, wherever they were needed to fly. They have worthily upheld the great traditions of their compatriots who fought in the Air Force in the last great war.

Newfoundland is a large but sparsely populated island. It cannot support a large air force. It has provided, so far, one squadron of *Defiants*. But this squadron, trained first for day fighting, has fought with the aggression typical of the Western Hemisphere. Three of its pilots, a squadron leader and two flight commanders, have won the D.F.C. It has fought over Dunkirk, where in one day it shot down 12 enemy aircraft. It has since specialised in intruder operations. Over enemy aerodromes its pilots wait at night for returning enemy bombers, shooting them down as they come in to land. The Newfoundlanders, whose numbers are rapidly growing, have achieved great success in these tactics too.

New Zealand has a great and proud tradition. Its pilots, gunners and observers are serving in innumerable squadrons of the RAF.

Some New Zealand Air Force crews were in Great Britain to collect aircraft when war was declared. They handed their aircraft over to the RAF and stayed to form a New Zealand flight, which was the nucleus of one of the New Zealand bomber squadrons of today.

New Zealand fighter squadrons, too, have done great work and in Flying Officer "Cobber" Kain the country produced one of the great figures of the war.

Other New Zealanders have also made their mark. One squadron shot down 11 out of 50 enemy aircraft in a single

engagement. The flight commander and another, both red-headed, together with the squadron commander, have destroyed seven enemy aircraft between them. They have brought to the New Zealand squadrons a spirit of immense tenacity and aggression.

The pre-war strength of the Royal Australian Air Force was roughly the same as that of the RCAF—about 2,400 men. Today the RAAF has reached 100,000. It will be far greater.

The RAAF has turned out 1,000 trained men each month for the last 12 months. Like the RCAF, with whom it has naturally a certain friendly rivalry, the RAAF has fought everywhere in the war where there were air battles to be fought. One famous flying boat squadron has hunted raiders and submarines and protected convoys in Northern waters, while others have protected shipping off the immense coastline of Australia itself. Its most famous *Spitfire* squadron was front-page news in the Battle of Britain, when it held or shared the record for numbers of enemy aircraft destroyed.

Royal Australian Air Force bomber units have also done magnificently. Australians are notable for that unpretentious and phlegmatic tenacity which is the essence of the good bomber crew. These men from the land—jackeroos, bushmen, wheat-farmers and stockmen—are characterised by their initiative and capacity for improvisation. They are undefeatable. A young Australian bomber pilot, for example, brought home a damaged *Stirling* on four successive occasions, once on three engines with a partial bomb-load and once when the aircraft itself was rapidly falling to pieces.

In this steadfast and unspectacular way Australian bomber pilots have taken the war to Brest, Lubeck, Rostock, the Ruhr and Cologne. Operating in conditions unfamiliar to them—it will be remembered that the conditions of Northern Europe were said to be similarly unfamiliar to Italians, who were accordingly withdrawn to milder latitudes—often in intense cold, rain and fog, the Australians have revealed marked adaptability as one of their finer qualities.

Of over 150 decorations awarded to Australians in all theatres of war about half have been won by Australians who joined the RAF before the war started; and of these Wing Commander H. Edwards, V.C., of Perth, Western Australia, is one.

Many South Africans and Rhodesians are serving in the RAF throughout the world; while the South African Air Force has been fighting in Africa since the outbreak of war. One of their many tasks was, and still is, patrolling the all important Cape shipping route.

South African Airways Junkers Ju-86 machines, converted into bombers, were used in long distance reconnaissance flights over this route. These aircraft early in December, 1939, intercepted the German liner *Watussi* off Cape Point and directed her towards the Naval base at Simonstown. The ship scuttled herself en route.

Within 24 hours of Italy's entry into the war on June 10, 1940, South African Air Force bombers were raiding Italian bases in Abyssinia and Italian Somaliland.

When in August, 1941, General Smuts spoke in commemoration of the 21st birthday of the SAAF, he mentioned that the force consisted of more than 2,000 officers and 25,000 men.

In the East African campaign, indeed, the SAAF, though greatly outnumbered by the Italian Air Force, established complete air superiority; and in due course played an important part in the victorious advance on Addis Ababa. After this campaign South African bomber and fighter pilots took part in the fighting in the Western Desert and in many important engagements in Northern Africa. Their Curtiss *Tomahawks* and Douglas *Bostons* wrought much havoc in the last Libyan campaign. The *Tomahawks* tackled Stuka dive-bombers and scored many successes—one day they shot down seven dive-bombers despite the escort of a score of Messerschmitts. Three of these fell to a single South African, Capt. L. C. Cooke Botha, who had never previously had a "kill." He "shared" a fourth. Two South African fighter pilots established a record when, after being shot down in the desert, each was picked up by another fighter—a *Tomahawk* and a *Hurricane* respectively. Each sat on his rescuer's lap and shared the controls for the return journey. One was picked up under the noses of a German armoured column. This feat had been performed before—but never twice in 12 hours.

Graduates of RCAF pilot and aircrew schools in Canada arrive in Britain trained under the Commonwealth Joint Air Training

Ground-strafing in the "cauldron" area occupied the greater part of the South Africans' time. One of their *Boston* pilots, returning from an attack on German tanks and supply vehicles, described the scene as a "confused mass of fighting, fire-belching vehicles, half-hidden by their own dust, half-concealed by the smoke of bursting bombs and black plumes of smoke from burning vehicles."

At the height of the campaign the South Africans—with the RAF and RAAF in the Western Desert—were flying continuously all day, running "shuttle services" of day bombers, fighter-bombers, and fighters from their aerodromes to the battle. Ground crews earned the highest commendation by the fierce enthusiasm with which they threw themselves into the task of keeping their aircraft serviceable—no light task in the desert heat when the planes were hardly ever on the ground for long. Bir Hacheim knew the Air Forces well during the magnificent stand by Free French troops against Rommel's armour. Pilots said they could find the Bir Hacheim

Nearly every convoy to Britain carries graduates of the Commonwealth Joint Air Training Plan. Australia alone has supplied 12,000 airmen in one year.

A cheerful group of members of the South African Air Force during one of their quieter spells in Libya.

front by flying roughly in its direction and looking for a great area in the sand which had been blackened by the fires from burned-out German transport that had been hit by bombs. Armoured columns were strafed and bombed repeatedly.

Before the war Southern Rhodesia had its own air force and at the outset sent a squadron to Kenya which, at the end of March, 1940, was embodied in the RAF. At the same time all Southern Rhodesian Air Force personnel were transferred to the RAF to form a fighter and a bomber squadron. It was this bomber squadron which took part in the famous Augsberg raid.

In other pages will be found more details of the splendid work of Dominion air forces and squadrons in the various theatres of war. One and all they are fighting magnificently at Britain's side in the common cause.

END

Machine gun sights are trained on the target, but only the shot gun fires. A Rhodesian officer practices with ingenious device.

Canadian fighter pilots, their "Mae Wests" attached, wait "at readiness" outside dispersal hut at a fighter station.

Carrying their kits and dressed accordingly, Dominions Royal Air Force reinforcements disembark at a Middle East seaport.

Back from convoy patrol duty, "Spitfires" of an Eagle Squadron fly across their base before landing. The pilot in the inset is known as the "Frisco Kid." Note Eagle Squadron insigne on his plane.

EAGLE SQUADRONS

Three squadrons of Yankee pilots are flying with the RAF today. The original Eagle Squadron has shot down 40 Nazis.

HERE are some of the pilots of the three Royal Air Force Fighter Command American Eagle squadrons who were already serving with the RAF in the front line of the air war long before the Japs attacked Pearl Harbor. These squadrons were the proud predecessors of the units of the U.S. Army Air Forces which are now serving on so many fronts.

The first squadron, the most famous because of its longer operational record, is led by Sq. Ldr. C. G. Peterson, D.F.C., from Santaquin, U., who was born in Salmon, Ida., on August 10, 1918.

This squadron completed its training in May, 1941, and has been taking regular part in daylight attacks on occupied France since the summer of last year. It has a score of nearly 40 enemy aircraft definitely destroyed and many more severely damaged.

Its leading pilots, some now with the other Eagle squadrons, include Flt. Lieut. G. A. Daymond, D.F.C., of Los Angeles, born at Great Falls, Mont., at one time the youngest member of the squadron, who equals Squadron Leader Peterson's score of five confirmed destroyed. They both received their D.F.C.'s on the same day, in October last, when Flight Lieutenant Daymond was only 19. They were the first Americans to win the award.

Flt. Lieut. Carrol Warren McColpin, D.F.C., formerly of the first and second squadrons and now with the third, is another holder of this high award. He was born at Buffalo, N. Y., and worked as an electrician at Los Angeles.

An ex-airline pilot, Pilot Off. W. R. Dunn, from Houston, Tex., got his first Nazi victims while still on the ground. He shot down two bombers with a Lewis gun when they tried to dive-bomb the camp where he was serving with a Canadian infantry regiment. Since then he has improved his score in the air with the Eagles, opening his account in the squadron's first big action when escorting bombers to Lille in July last year. At one time he was the squadron's top-scorer, reaching five destroyed, before Peterson or Daymond.

Other prominent Eagle pilots are Flt. Lieut. N. Anderson, a Chicago journalist; Pilot Officer O. H. Coen; Pilot Officer Jim Daley, of Amarillo, Tex.—who recently broadcast to the United States; Pilot Officer Tribkin, and Pilot Officer J. J. Lynch from Alhambra, Calif., an ex-aeronautical engineer in the U. S. Army Air Forces.

Lynch crossed the Canadian border to fly with the RAF and his most spectacular flight was when he hit a telegraph post in France and flew back with a piece of it embedded in his wing.

The second Eagle squadron made its debut while still in training by probably destroying a Junkers Ju. 88. The pilots who shared this combat were Sergeant Mooney and Pilot Officer Edner. Sergeant Mooney, from Long Island City, N. Y., is now a pilot officer. He once flew back from an offensive over the Dutch coast with three cannon shell and 30 machine gun bullet hits in his aircraft and a seagull in the carburetor intake. Edner has since added two Focke-Wulf 190's destroyed.

The squadron has destroyed seven enemy aircraft on offensives over the continent. Its pilots, operating in pairs, have shot up warehouses, storage tanks, trains and German gunposts.

(*Continued on page 274*)

Something's up—and these four Czech fighter pilots are eager to join fray.

ALLIED AIR FORCES

Undaunted airmen of many conquered nations now fly with the RAF to avenge the Nazi invasion of their homeland.

by

GROUP CAPTAIN A. S. W. DORE, D.S.O., T.D., D.L., was born September 16, 1882. He now is the Deputy Director of Allied Air Co-operation and Foreign Liaison. Originally an Army man, he was commissioned in 1905, in the Worcester Territorials. Wounded in action in World War I, he was awarded the D.S.O. From 1930 to 1935, he commanded 604 (Fighter) Squadron, County of Middlesex Auxiliary Air Force and is vice chairman of the Middlesex Territorial and Air Force Association. Group Captain Dore acquired an intimate knowledge of Nazi air tactics during his term as assistant air attache in Norway in 1940.

FROM the Wars of the Crusades down to the recent civil war in Spain, history can show many examples of international fighting forces banding themselves together to fight for religious, social or political ideals; but never in the history of warfare has there assembled in any country or for any cause, a force of such skill and determiniation and embracing so many nationalities, as the armed forces of the United Nations now mustered not only in Great Britain but on every front where the enemy is to be found. Not the least of these are the Allied Air Forces co-operating with the Royal Air Force and sharing with them the honours gained in the Battle of Britain, the Battle of the Atlantic, the night defence of the British Isles, and the intensive bombing of enemy territories.

After the invasion of Czechoslovakia, Poland, Norway, Holland, Belgium and France these airmen came to our shores by many routes after almost incredible adventures, and sometimes almost unbearable sufferings. Their stories make up an epic of heroism. Some came by small sailing vessels or even row boats across the North Sea, many perishing on the way from hunger or exposure. Some stole aircraft under the eyes of the Germans, and landed safely to carry on the struggle. Others were brought over by their own ships or the British Navy.

The Czechs found their way to France, fought there until the collapse, and were then brought across the Channel to rest and refit. In a very short time they had learned to fly RAF aircraft and were formed into fighter and bomber squadrons of their own to fight alongside the British. At least one Czech arrived in England by way of India and Cape Town. Many

Within six weeks, Polish pilots of this "Hurricane" squadron, operating from a British base, downed 126 Nazi craft.

Norwegian pilots (note shoulder tabs), serving with the RAF in Iceland, study the operation of an astro-compass.

Known as "Mae Wests" to RAF pilots, the life preserver worn on over-water flights amuses these Belgian flyers.

Poles were interned in Russia, working in mines or on farms until the entry of Russia into the war finally set them free. In all cases they were prompted by a resolution, often grimly fanatical, to reach England and to go on flying and fighting. Of those who reached France many fought the Germans with extreme courage, flying obsolescent machines against the superior organisation of the Luftwaffe, only to find on the fall of France that their escape had to be attempted again.

After the invasion of Poland large numbers of the Polish Air Force made long, amazing and often painful journeys to escape through Russia, Roumania and Syria to fight for France. Like the Czechs they would not give up the struggle when the French laid down their arms, and eventually they too reached England to form the nucleus of a new air force imbued with undimmed determination to carry on the fight against the Hun.

The Norwegians had few means of escape. Their Navy and Army Air Forces had been practically destroyed as fighting forces after the surprise invasion of their country. Some flew their floatplanes to Scotland, some sailed or even rowed their way across in small boats, others escaped into Sweden. Undaunted by their small numbers, the Norwegian Government in Great Britain arranged with the Canadian Government to set up a training camp near Toronto, now widely known as "Little Norway." There they gathered together in Canada and from the United States many recruits who were later welded together into a compact and efficient air force, instructed partly by their own pilots who had escaped from Norway, and partly with the aid of the Royal Canadian Air Force. This was a most difficult task, but nevertheless Norwegians are now fighting in the United Kingdom as a national air force co-operating with the RAF.

This story of high courage and determination applies equally to the Belgians, the Dutch and large numbers of French pilots and air personnel who left their countries when Europe was overrun by the German hordes to fly and fight again with the British. To shape these remnants of national air forces into a disciplined and fighting organisation was partly the task of the RAF, who have equipped them with British machines, placed aerodromes at their disposal and thrown the training organisation wide open either to train them on new and unfamiliar types of aircraft, or to start them as novices and coach them through the many stages of flying training.

The problem of language was very great; differences in training methods amongst these Allies were considerable. The arrival in England even of units of Allied airmen did not necessarily mean that those units were complete with ground crews, aircrews or administrative staffs.

Of all these difficulties that of language had to be tackled first since a working knowledge of English was essential, not only that the Allies might be trained in RAF schools, but also to enable their air forces, which are necessarily under the operational command of the RAF, to speak a common language. Interpreters were selected and RAF education officers appointed. And the difficulty of language was gradually broken down and the task of retraining and rebuilding begun. It is perhaps significant that English has now become the common language of the allied air forces. If an international air force is ever needed to police and control a beaten Germany there exist in Britain all the needful elements with a common ideal and fighting spirit, a common tactical doctrine standard equipment, a mutual sympathy and comradeship in arms which will never be forgotten, and a language common to the English speaking world.

Of all the escaped nationals, the Poles still remain numerically the largest air force. The reasons are simple. Before the war the Polish Air Force was rich in numbers but not strong in aircraft. When Poland was over-run by the vastly superior German army and air force their machines were destroyed, but a large part of their trained pilots, observers and maintenance personnel survived. The success of these Poles in air battles has become proverbial and their fanatical deter-

Free French airmen work on a "Spitfire" named "Mountains o' Mourne" by readers of a Northern Ireland newspaper, who purchased it for the RAF.

A dozen members of one of the first Eagle Squadrons, composed of American pilots who volunteered early in the war. Plane in background is a Hawker "Hurricane" single-seater interceptor-fighter.

mination to kill Germans a legend. In the Battle of Britain a Polish *Hurricane* squadron destroyed 28 enemy planes in three days. Another claimed 150 victories, of which 127 were accounted for in three months. Up to the end of April,. 1942, over 450 enemy aircraft had been destroyed by the Polish Air Force, not counting those *probably* destroyed. These were their fighter squadrons. Polish bomber squadrons have been no less successful against Germany and German occupied territory. Many Polish pilots have flown an almost incredible number of hours on operational flights, even up to 3,000 hours on operations is not uncommon. Nor must the high technical skill of the Poles be overlooked. Many of their technicians are as highly trained and as competent as any in the world, and their skill is now at the disposal of their squadrons and of the RAF. The Poles have helped also with distinction in research, which is an essential of modern warfare.

The Czechs, like the Poles, are excellent engineers. Coming from the Skoda Works, many of them have shown great aptitude in aero-engineering. Their fighter squadrons have been most successful and in the Battle of Britain one squadron alone shot down 50 enemy planes. They have recently shown great success and determination as night fighters, while their bomber squadrons have raided Germany and the Channel ports.

Escape for the Dutch was less difficult, perhaps, than for the airmen of other countries. The distance was short; the back-door was the sea. Large numbers of the Royal Dutch Air Force took their opportunity. The Dutch, as one might expect from a nation of long seafaring history, have distinguished themselves greatly in Coastal Command, a Command which, during 1941, flew 143,000 operational hours and some 17,000,000 miles, over an area stretching from Ireland to Gibraltar, bombing enemy shipping, depth charging U-boats and protecting convoys on the North Atlantic and other sea lanes. Many Dutch pilots were originally Army pilots who are now found with pilots of the Royal Dutch Naval Air Service in separate units with maintenance crews of their own. They too helped in the defence of Britain, both the Netherlands Government and the Government of the Netherlands East Indies generously providing the funds for many aircraft. One Dutch observer recently decorated with the D.F.C. successfully brought his American-made *Hudson* safely back from the coast of Norway after his pilot had been killed; and although he had never learnt to fly and his aircraft was badly shot about, he landed safely and so saved himself and the lives of his crew.

As with the Dutch, so with the Norwegians. If their ways of escape were less simple, their temperament, traditionally akin to the sea, fitted these men admirably for service with Coastal Command. Naturally assigned to far northern waters, the Norwegians, like the Dutch, have done splendid though necessarily unspectacular work in the guarding of convoys to Iceland and to Russia, in Coastal reconnaissance and all the monotonous but vital routine work for which Coastal Command gets little publicity. There is now also a Norwegian fighter squadron.

Under the leadership of General de Gaulle the Free French Air Force too was created, and units were formed for service in Free French territories overseas. Many Free French pilots have in addition rendered invaluable service as members of RAF squadrons.

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Carrier pigeon (in basket held by flyer at left) accompanies members of Royal Netherlands Naval Air Service on reconnaissance flight in "Hudson."

AVIATION MEDICINE

by Harold E. Whittingham.

AIR MARSHAL SIR HAROLD E. WHITTINGHAM, K.B.E., M.B., Ch.B., F.R.C.P. (London and Edinburgh), F.R.F.P.S. (Glasgow), D.P.H., D.T.M. & H., K.H.P., DIRECTOR GENERAL OF THE ROYAL AIR FORCE MEDICAL SERVICES, was originally commissioned in the Royal Army Medical Corps in 1916 and, in 1918, was transferred to the Royal Air Force (Medical Branch). He was commended by the Air Council for his researches conducted in Malta into the origin and prevention of sandfly fever. Sir Harold has commanded the RAF Pathological Laboratory at Halton and has been Director of Hygiene at the Air Ministry.

Maintaining the physical welfare of Britain's flying personnel is the task efficiently faced by RAF Medical Services.

BRITISH medical specialists—doctors, scientists and research workers—have been playing a part in the air war as vital as that of the combat crews and aeronautical designers. In fact much of the success of Britain's bombers, day and night fighters and other combat ships is directly due to the work of the investigators into the problems of aviation medicine who are teamed up with the Royal Air Force.

Physiological efficiency of men during high speed aerobatics, at high altitude, and under high pressure fighting conditions —these are among the big problems which British medicine has set itself to solve in the unending task of keeping the human factor in step with the ever advancing state of aeronautical construction and performance. That is in addition to the less exciting job of guarding the general health and fitness of many hundreds of thousand men and women now in Air Force blue serving under all sorts of climatic and other conditions.

Not much has been heard of the medical men's work. It is not often front page news. But the single fact that the RAF Medical Service has today over a hundred flying doctors, men who have taken their wings as pilots in order the better to test medical theory and fact under actual flying conditions, gives an idea of the size of the problem, and the way it has been handled.

Let me give an example of how the doctors aid the pilots.

Maybe there is a problem of ocular fatigue to be solved. High flying bomber pilots, caught in the glare of enemy searchlights, may find their eyes dazzled. Somewhere there is a medical and ocular solution; special devices, special dull surfaces, or special coloured lights may provide the answer.

One of the flying doctors of the RAF goes up to meet a full scale searchlight demonstration, and from his first-hand experiences the patient research workers get out the answer. That is just a single incident.

Add the fact that certain medical men of the RAF have lost their lives in these flying researches during the war and it will be seen that although their work cannot be front page news, it is not all done in the "back room."

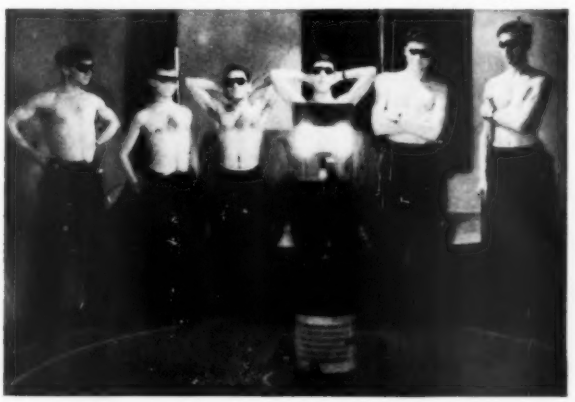
Specially intensive researches by the RAF Medical Service into the modern problems of aviation medicine was in train before the war began. In January, 1939, the Flying Personnel Research Committee was appointed. Their terms of reference were "to advise the Secretary of State for Air on medical matters affecting the welfare and efficiency of RAF flying personnel; and to advise on researches connected with the physiological efficiency and scientific selection of members of air crews."

The stores at this Maintenance Command depot typifies the care taken to provide medicaments for any injuries.

Since then much water has run under the bridge. As a result of the committee's researches marked improvements have been made, both to flying apparatus and in aircraft design, calculated to enable man to keep pace with the progress of the machine.

Particularly striking is the success won over that old bogey of high speed flying, acceleration. This is the main factor which causes blacking-out, or temporary loss of vision. The

Night fighter pilots, who must seek their sleep during hours of sunshine, receive their "ration" of violet-ray.



Pilot (at left) was flying 20,000 feet above the Atlantic when this picture was taken. His oxygen mask ensures full control of all his faculties. Oxygen bottles (above) are loaded aboard planes with the same caution accorded bombs.

RAF medical experts have now devised means by which man can bear greater stresses of "g" than the aircraft itself. In this direction British aviation medicine is at least a jump ahead of the enemy. Another problem that has been solved is the perfection of the high-flyer's oxygen apparatus. The latest British apparatus is at least 100 per cent more efficient than that in use at the start of the war.

New flying clothing has been designed on scientific principles to give the greatest possible protection against cold. This is essentially a problem for the medical man, with a deep knowledge of such factors as the respiratory and circulatory systems of the human body. A whole lot of dead-wood in the way of pre-conceived notions about where and how to apply heat had to be cut out before that particular answer was found.

Acoustic studies have led to the development of a new and very efficient flying helmet, more comfortable in wear and with better protection against engine noise, yet with markedly better reception of inter-communication. And means have been found of protecting crews against the insidious peril of carbon monoxide from the engine; a new device detects even the minutest amount of this gas in the cockpit or cabin.

Before considering in detail some of the directions in which aviation medicine has helped the men whose job it is to fly and fight in British aircraft under all sorts of conditions, it is worth while looking at another aspect of the work of the RAF Medical Service. That is the selection of men both for flying and other duties on a scientific medical basis.

A wartime development of Britain's programme of air recruitment is the extension of these selection tests to ground staff as well as to air crews.

Both ground staff and air crews are given a psychological interview on lines developed by teams of scientists from Cambridge and Oxford universities. These tests are generally applied by specially trained WAAF personnel. An example of a specialist trade test with a medical foundation is the tapping test devised to ascertain the suitability of a man's hands for wireless work.

Under modern high speed and high altitude flying conditions it is vital that both pilots and air crews should be alert in mind and have accurate vision, a good sense of balance, good muscle tone and quick reaction time. The standard pre-war RAF clinical examination, similar to that also used in other air forces, was designed to assess the general physical fitness of a candidate to withstand years of stress of flying under peace and war conditions. Whilst useful for that purpose it did not predict an individual's aptitude to learn to fly. Something more was needed if wastage of untrainables was to be kept down.

About 90 per cent who cannot learn to fly properly, or take more than average time, fail through an inherent lack of flying ability. This is due to either a poor power of muscle-joint co-ordination and a slow reflex reaction, or some psychological factor. To find the deft hands and feet which go with the natural flying aptitude candidates are given a "flying aptitude test" on an arm-leg co-ordination or sensory motor apparatus. This tests fine and graduated co-ordinated movements of one arm and both legs, whilst the man under test is distracted by visual and auditory signals to which he has to respond by movements with the free arm. In a pilot's seat, complete with rudder bar and control column, the candidate faces an illuminated test cabinet fitted with a circular domed screen of opalescent glass and geared to the controls. Cross lines mark the screen's centre and a spot of light, actuated by a disc revolving inside the cabinet, moves in an irregular course across the screen. The candidate has to neutralise the movements of the light spot, keeping it central on the screen, by movements of

(*Continued on page* 188)

Before taking off, night fighter crews wear dark glasses. This will accustom eyes to a dim light.

Ears of a prospective air gunner are given a thorough test.

The convergence test, which helps ascertain eye reactions.

Checking candidate's pulse as he blows into measuring device.

The ordinary blood pressure test must be taken by applicants.

Sense of balance is determined by one-legged stand, eyes shut.

MACHINE USED AS "PILOT TESTER"

CANDIDATES for pilot assignments receive a special flying aptitude test developed to reduce wastage of time and materials consumed in ascertaining an applicant's reaction by taking him through the early stages of actual flight training. In addition to the routine tests as shown on this page, prospective pilot material is installed in a model pilot's compartment where his ability to co-ordinate hands and feet, as in actual flight, is carefully recorded by means of control board.

His eyes closed, candidate must identify tones of tuning forks.

Scaled instrument reveals applicant's eye convergency rating.

Examining doctor watches closely for signs of finger tremor.

AIR-SEA RESCUE

A high-speed launch searching for enemy, as well as Allied, airmen downed in the English Channel.

Many devices aid the RAF's "navy" in the highly efficient operation of its rescue service created to save lives of airmen.

by G. Waring

GROUP CAPT. E. F. WARING, D.F.C., A.F.C., DEPUTY DIRECTOR OF AIR-SEA RESCUE, has a wide knowledge and appreciation of air and Naval co-operation. He served in the Royal Naval Air Service during the first World War, before transferring to the RAF in 1919. He was awarded the D.F.C. and won wide acclaim in August, 1918, by his sinking of an enemy submarine from his aircraft. He has seen service on aircraft carriers, and his experience with ships of the sea and of the air has been expertly combined in his conduct of Air-Sea Rescue Service, which requires the closest co-operation of the Royal Air Force and units of Royal Navy.

THE organisation which is saving our airmen from the sea in ever increasing numbers is the Directorate General of Aircraft Safety, one branch of which is the Air/Sea Rescue Service. It is directed by Marshal of the Royal Air Force Sir John Salmond. Before describing this work, its origins, and the part played in it by the Royal Navy—which is as much concerned with the work of rescue as the RAF—it is necessary to describe the problems involved.

They are four in number. First, the airman must be provided with the means of remaining afloat. Secondly, he must be able to keep himself alive. Thirdly, he must be found. And fourthly, he must be brought safely to land.

The shock when an aircraft, be it fighter or bomber, strikes the water is tremendous, even though it is landed at the lowest possible speed and in a stalled position so that the tail strikes the surface first. The crew of a bomber are told to brace themselves against the main strut or bulkhead or some portion of the aircraft which will not collapse when it strikes the water. Ropes are also provided to which they can cling. This bracing of the body is strongly impressed on all crews.

If the descent into the sea is made by parachute, the airman, when about 100 feet from the water, rotates the quick release button on his parachute harness. Then, when within a few feet of the surface, he straightens his body, puts his feet together, holds his nose and pulls his elbows well into his sides. As his feet touch the water he strikes the button which releases his paracute harness and takes a grip of the lanyard to which his dinghy pack is attached. Once in the water the airman can keep afloat by means of his life-saving jacket, usually known as "Mae West," or more often in a rubber dinghy.

In fighter aircraft the dinghy forms part of the parachute pack on which the pilot sits, and it is attached by the lanyard to the all-important "D" ring on the pilot's "Mae West." A bomber's dinghy is in most cases carried in the wing and is inflated and shot out automatically when the aircraft alights on the sea. The dinghy is inflated by a bottle of carbon dioxide which is opened by an automatic immersion switch. If this fails it can be inflated by hand.

Dinghies are of various types. The "K" type is the single-seater used in fighter aircraft. It carries a waterproof sheet which can be pulled up to the chin, thus completely covering its occupant. Other types are fitted in bombers, some big enough to hold a crew of six or more. In the larger bombers and in flying boats, all of which have a larger crew, more than one dinghy is carried.

Each airman in the crew is required to wear a yellow skull cap and a yellow life jacket—"Mae West," the kapok lining giving enough buoyancy to allow the wearer to delay blowing it up until after he has left the aircraft. If a man should blow it up before leaving he may stick in the door of the aircraft or in the astro hatch. Each member of the crew has a particular

One of the rescue boats nears its goal and prepares to pull aboard two airmen who have been paddling their rubber dinghy towards shore while awaiting the 63-foot launch which typifies "safety."

duty before, during and after ditching. Thus, for example, the wireless operator is responsible for taking with him the Very light pistols, for destroying the secret papers and for stowing in the dinghy the carrier pigeons and the distress signals. The other members of the crew have similar tasks to perform.

Apart from dinghies there are floats and buoys. A float is a boat-shaped hull 30 feet long painted bright red and orange. It is oblong in shape and is fitted with grids and bars extending below the water line to act as foot and hand-holds. The stern of the float is cut away at an angle so that the ladder over it hangs straight down and can thus be climbed more easily. The sides are raised to give protection to a man lying on the deck should he be too exhausted to enter the cabin immediately. The floats, which are moored at intervals round our coasts, are equipped with signalling apparatus, food (preserved meat and vegetables, biscuits, tea, cocoa, sugar, brandy or rum, drinking water) and a primus stove on which to cook. There are also complete changes of underclothing, sleeping bags, towels and washing gear. To while away the time before the rescue craft arrives, there are cigarettes and matches, books, magazines, games such as chess and draughts and playing cards. A float can hold at least six men.

In addition to the float, which has been specially built for its purpose, advantage has been taken of the large number of buoys to be found outside British harbours and estuaries. Many of these have been equipped with ropes and ladders leading to the cage containing the light. Inside the cage there is a chest containing rations, a first aid box, a yellow flag (yellow is the colour most easily seen at sea) distress signals, drinking water, a torch and a whistle.

Thus an airman who abandons his aircraft can keep afloat and keep alive. But how is he to be found and brought to land? There are aircraft specially allotted for air/sea rescue operations and, in addition, any other aircraft available are used for the purpose of air search and some of these are fitted to drop dinghies and other rescue equipment. The RAF rescue craft consist of pinnaces, two types of high speed launches and seaplane tenders, the latter suitable for calm weather only. The naval craft too are of considerable variety and range from motor-boats to converted private yachts.

The Royal Navy and the RAF work together in the closest harmony. The RAF find the airmen adrift on the ocean. The Royal Navy picks them up and brings them to land. The high speed RAF launches manned by RAF personnel, the motor-boats manned by Naval ratings, the lifeboats with their volunteer crew of men of the lifeboat service, the trawlers with their

Dinghy designed for pilots of single-seater fighter aircraft. Note hand pump on near side, used to inflate tube.

This dinghy accommodates crews of smaller bombers. Note the rum and ration containers, signal lamp and paddles.

Moored at intervals in the Channel, especially designed and well provisioned floats permit self-rescue of airmen.

complement of fishermen, are each and all under the direct operational control of the Royal Navy, which will also divert any craft in the neighbourhood towards a dinghy. The air search is conducted by fighter Command aircraft if the dinghy is near our coasts and by aircraft under the control of Coastal Command if the airmen have come down farther out.

This was not always so. The RAF has for some years had in its possession a number of launches, some of them high speed, which have been in use at the various RAF stations, more particularly those belonging to Coastal Command. When war broke out, some of these craft were earmarked for the purpose of rescue. In the early days, when the only targets attacked by our bombers were warships in or near the harbours of the enemy, they were deemed adequate for the purpose. When, however, our attack on German land targets opened on May 11, 1940, and when by the middle of June that year France had collapsed and the Battle of Britain, which was to rise to a climax in August and September, had begun, an immediate expansion of the service became imperative.

The most pressing problem was to rescue fighter pilots engaged with the enemy over the south and southeast coasts of Britain. For this purpose Fighter Command borrowed a number of Westland *Lysander* aircraft from Army Co-operation Command. They were given fighter escort lest the enemy should interfere with them, and they went out after each engagement carrying rubber dinghies in their bomb racks which were dropped as close as possible to the airmen in distress. In those early days a rescue from the sea was a matter of great difficulty, for the pilot was not then provided with a dinghy attached to his person. Nevertheless, a certain measure of success was achieved by close co-operation with the Royal Navy. A rescue service, operating mainly in the Dover area, was started towards the end of May, 1940. Special craft were not then available and craft used in active operations against the enemy had therefore to be employed despite the fact that they could legitimately be made the object of enemy aircraft attack. Vessels of this kind continued to be used throughout that year, for such other craft as could be spared for the purpose of rescue were, in many cases, found to be unsuitable or unreliable. By the end of October, 1940, when the Battle of Britain had been won, some 30 airmen, most of them British or Allies, had been rescued. The boats engaged in this work were sometimes attacked by enemy aircraft. Some were damaged and casualties were incurred, though at one period there seemed to be an unwritten law that rescue craft, both our own and the enemy's, should be immune from attack provided they kept to their own part of the Channel.

Meanwhile an air/sea rescue service had come into operation under the control of Coastal Command. The aircraft of Bomber Command were in full operation over north and northwestern Germany and the aircraft of Coastal Command had opened their attack on fringe targets from Trondheim to Bordeaux. The number of aircrews falling into the sea was inevitably beginning to increase with the development of these attacks. Their rescue became of the first importance. Speed is, and must always be, a vital factor. It was therefore decided that those controlling the air/sea rescue services should do so in conditions which would make it possible for the Royal Navy and the RAF to work in the closest co-operation.

This part of the task was easy. The area combined headquarters of the groups of Coastal Command have, from the beginning of this war, been manned jointly by the Royal Navy and the RAF. Here then were the places ready to hand in which those controlling air/sea rescue would obviously be able to fulfill their task with the minimum of delay. Watchkeepers were accordingly attached to each Group of Coastal Command and a rescue technique rapidly systematised.

As soon as an SOS is received from an aircraft, whoever picks it up, whether it is the aircraft's own station or its own group headquarters, immediately communicates by telephone to the nearest Area Combined Headquarters. There the message is handed at once to the control staff who get into touch with the Controller of the Group in whose area the aircraft is reported. The Group Controller in his turn informs the nearest Coastal Command station and a reconnaissance aircraft is despatched, usually immediately, but always the moment circumstances permit. While these steps are being taken by the officers of the RAF, those of the Royal Navy are also taking action. Area Combined Headquarters warns the nearest Naval station at which a launch or other rescue craft are available. These put to sea as soon as possible and are directed to the dinghy by messages received from the reconnaissance aircraft. Rescue vessels of various kinds have been stationed along our coasts.

A *Whitley* returning from Italy found itself off course, owing to adverse weather and unreliable wireless. The pilot knew that petrol was running low and he would probably have to ditch. Just before the engines faded the wireless-operator succeeded in sending an SOS which enabled the *Whitley* to be plotted some 40 miles off Plymouth. There was a slight southerly wind, the sea was calm, there was little moon and no mist. After switching on his landing lights the pilot made a successful tail-down landing. The dinghy was inflated without incident. All the crew scrambled aboard, the only mishap being an injury to the tail-gunner who broke his arm when the *Whitley* hit the water. They entered the dinghy at 4:30 in the morning. They were found by a *Lysander*, which had gone out immediately to search for them, at 10:50 hours—five hours and 35 minutes after ditching. The *Lysander* approached them with the sun behind it and its pilot saw them easily. They had used Fluorescine (which leaves a yellow trail on the sea) as soon as daylight appeared. The launch arrived at 14:30 hours and picked them up.

The rescue service has been carried out on these lines with increasing success.

Now special rescue aircraft squadrons have been formed and on all stations of Coastal Command, and on some stations of Bomber Command whose location makes them convenient places from which to operate, one aircraft or flying boat with a crew stands by in readiness to go out if the necessity should arise. Coastal Command have full operational control over all aircraft engaged on deep search. Fighter Command control all their aircraft which are used for close search only.

The operation of these aircraft gives rise to more problems. For example, the farther a searching aircraft has to fly the more likelihood there is of error. A rubber dinghy is a very small object in the grey wastes of the sea. An error in navigation, however slight, is cumulative. The farther an aircraft moves the larger such an error becomes; and this same principle applies alike to the aircraft in the sea and to the reconnaissance aircraft searching for its crew.

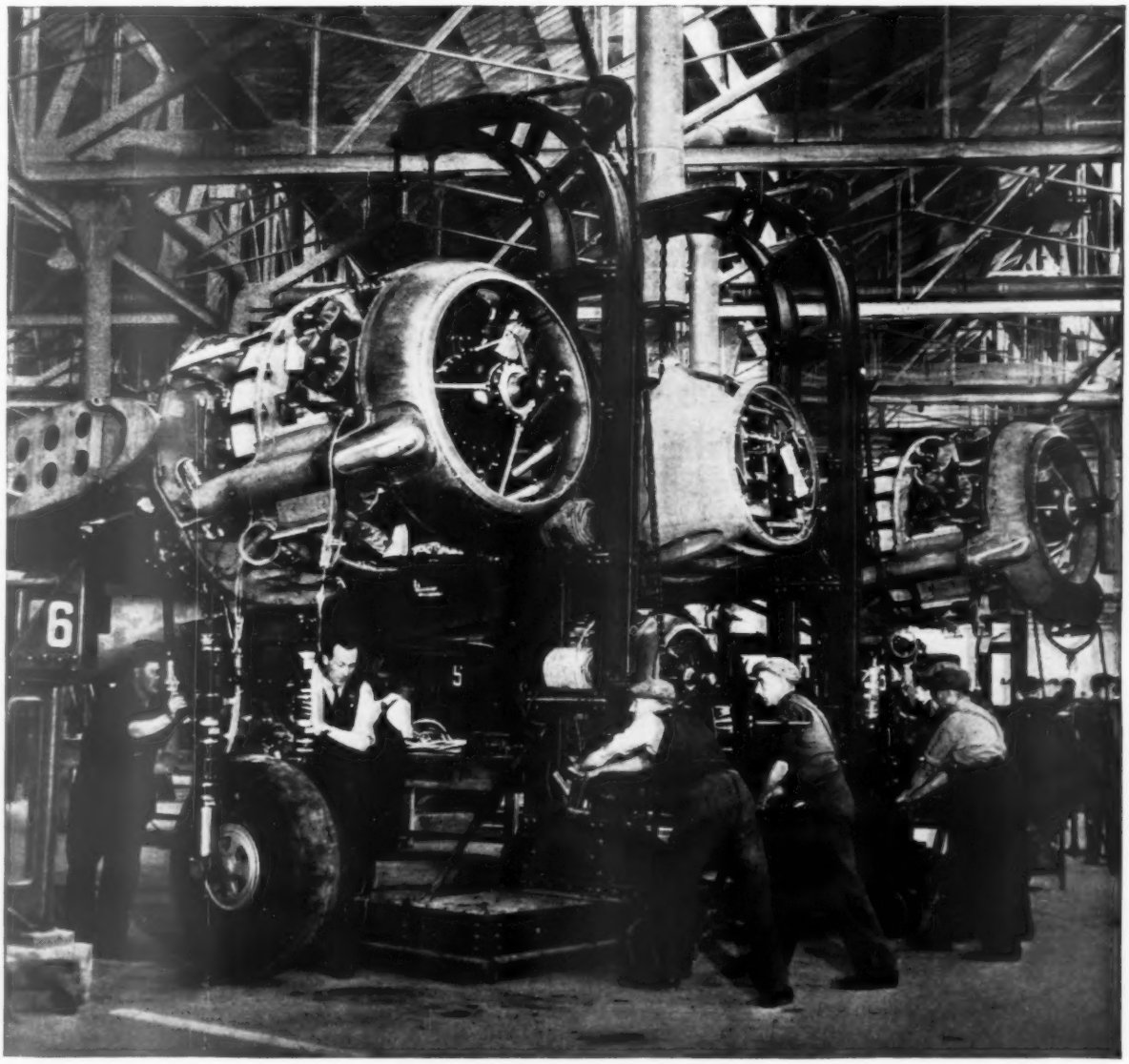
There is finally the problem of visibility, which confronts both air and sea craft alike. The vagaries of the weather over the North Sea and the North Atlantic are very great and very troublesome.

The difficulties confronting the naval craft are, on the whole, the greater. While a medium bomber like the *Hampden* or a reconnaissance aircraft like the *Anson* or the *Hudson* is prevented from flying only by icing conditions or by complete lack of visibility, the choice of the Royal Navy of the craft to be

(*Continued on page* 275)

AIRCRAFT SECTION

To the British, too, this is a war of production as well as tactics. In the following section is described the many ways British ingenuity has finally surpassed German mass production.



A Bristol "Beaufighter" being assembled.

Foreword by

Colonel The Right Honorable J. J. LLEWELLIN, P. C., C.B.E., M.C., T.D., M.A., M.P.
MINISTER OF AIRCRAFT PRODUCTION

At the end of the last war Great Britain had a very large Air Force. During the immediately succeeding years we progressively decreased that force in order that we might not only preach, but also practice, disarmament. The manufacture of military aircraft naturally declined in a corresponding degree, and the industry had still not been re-established on any large scale when war broke upon us. Not until May, 1940, just prior to the fall of France, was the Ministry of Aircraft Production formed.

Aircraft production in this country has now become one of the greatest productive organisations in the annals of British Government. Aeroplanes, engines and aero equipment of all kinds are produced by men and women who have never done such work before. From a few thousands their numbers have risen to several millions; from a few hundreds of aeroplanes, our Air Force has grown to a strength of many thousands.

We are watching the prodigious growth of American production with admiration. As Minister of Aircraft Production, I am sure that our team of workers—alongside yours—will build in ever increasing quantities the bigger bombers, the better fighters, which will play no small part in releasing humanity from the dangers and disasters which threaten.

J. J. Llewellin

THE WORK OF THE MINISTRY OF AIRCRAFT PRODUCTION

by A. T. Rowlands.

THE Ministry of Aircraft Production was born of the exigencies of war.

It was brought into being in May, 1940, by an Order in Council, which defined its functions as being:—

(a) the supply and repair of aircraft, munitions of war, stores and equipment required by the Secretary of State for Air or the Air Council for the purpose of the discharge of their functions; and

(b) the design and inspection of, and research and experimental work in relation to, any articles required by the Secretary of State for Air or the Air Council for the purpose aforesaid.

Previously, both in peace and in the early part of the war, these duties had been carried out by a special department of the Air Ministry, but they were expanding so rapidly that the Prime Minister decided to entrust them to a separate Ministry —leaving the Air Ministry free to devote its attention to the administration of the Royal Air Force and to the conduct of the war in the air.

A description of the principal departments of the Ministry is given in separate articles of this issue. From these, it will be gathered that the Ministry does not itself produce aircraft. It decides, in consultation with the Naval and Air Staffs, what kinds of aeroplanes should be produced, how many of them should be made up to the full limit of the resources which can be made available for the purpose and where they are to be produced. It lays down, controls, adjusts and watches over the fulfilment of the master plan of production, but leaves the actual manufacture to industry. It has spent hundreds of millions of pounds on the construction and equipment of new, or on the adaptation of existing, factories; but it manages none of them. The management is entrusted to private firms.

In brief, the primary task of the Ministry on its production side is to create the optimum conditions required to achieve the maximum output.

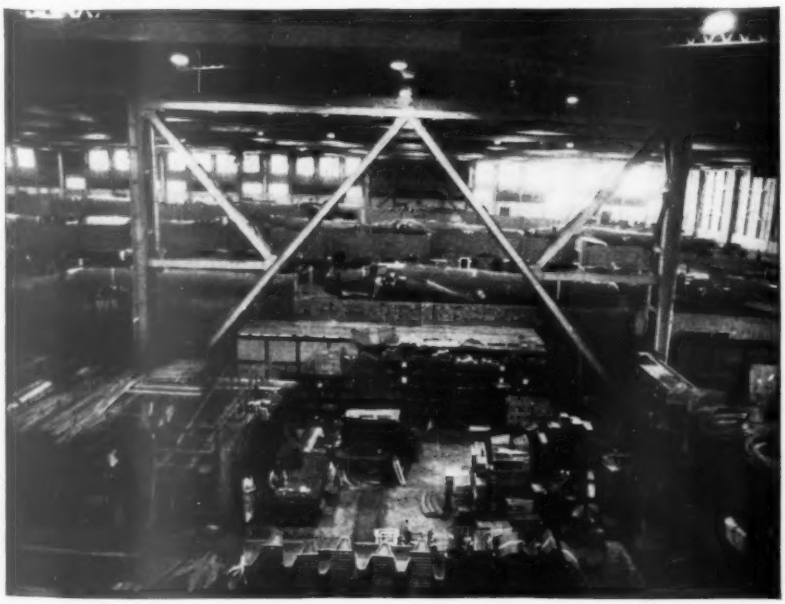
This has involved not only an enormous expansion of airframe and aero engine plants, but also the creation of corresponding capacity for the manufacture of the fabricated material, the instruments, the armament, the equipment and the many other thousands of separate items which go to make the modern combat airplane. The manufacturer who turns out the finished aircraft or aero engine has to be assured of his supplies, and it is the job of the Ministry of Aircraft Production to see that they are available at the right time and in the right quantities.

SIR ARCHIBALD ROWLANDS, K.C.B., M.B.E., Permanent Secretary of the Ministry of Aircraft Production. Former Second Deputy Under-Secretary of State, Air Ministry. From 1937 to 1939, he was adviser on military finance to the Government of India. Born December 26, 1892, Sir Archibald was educated at the University College of Wales and Jesus College, Oxford. He served in Mesopotamia in the last war. He served as Private Secretary to successive Secretaries of State for War (Viscount Hailsham, Viscount Halifax, Mr. Duff Cooper). He was created a Knight Commander of the Bath in 1941.

It is to the Ministry, too, that the contractor and sub-contractor look for the machine tools, the plant, the labour and the premises, which they are unable to obtain by their own unaided efforts, for all these things are in short supply.

The task of trying to overtake the almost overwhelming numerical superiority in aircraft and military weapons with which Germany entered upon this war has entailed the sacrifice of all non-essential industries and the severe restriction of those engaged in supplying the minimum civilian needs of the country. A factory formerly making musical instruments is now making gun turrets and tail planes; a factory once making coffins is now making aeroplane wings. Automobile firms are making aero engines. Indeed, the automobile industry was the main instrument for expanding the output of aero engines. Railway workshops do airframe repairs and make tanks; piano firms are making RAF pyrotechnics and Army ammunition boxes; aerated water firms are making oxygen and wireless apparatus; the large clerical staffs employed by the football

Completed portions of Vickers "Wellington" bombers are stored here for future assembly. In the background are fuselages, complete with engines and turrets.



This production control room directs one of Britain's underground aircraft plants.

Chalk mines and quarries have been converted into underground factories. These workmen are digging out a new factory exit.

pools, which formerly catered for the sporting interest taken by the British working man in the results of football matches on Saturday afternoons, gave up their typewriters and computing machines to take over sewing machines for the making of barrage balloons; furniture makers are making gliders; and so on.

Not only have the main aircraft firms, which constituted the pre-war aircraft industry, grown to an enormous size, but it has also been necessary for them to sub-contract a large percentage of their work to existing smaller engineering enterprises throughout the country; so that almost every available garage and workshop is engaged on sub-contracts for the larger factories. The advantages of this scheme are manifold. First, machine tools already available are brought at once into production. Secondly, the work is taken to where the labour is available, instead of the labour having to be brought to the work, with the consequential transport and housing problems involved. Indeed, it is not too much to say that the expansion in output which has been achieved would not have been possible but for the comprehensive sub-contracting scheme laid down by the Air Ministry before the war and developed by the Ministry of Aircraft Production.

But it is not only to the plants producing new aircraft that we look to maintain and increase the first line strength of the RAF. We have had to create a large industry for the repair of damaged aeroplanes, aero engines and equipment, and the product of this new industry provides a powerful reinforcement to the output of the main factories.

Special mention should be made of two pieces of organisation evolved to meet the aerial bombardment which struck these islands in the Summer of 1940, and which continued with little respite until the end of May, 1941. These are not the least among the great improvisations of Lord Beaverbrook, the first Minister of Aircraft Production. The first is what we know as the Emergency Services Organisation of the Ministry of Aircraft Production—although it looks after the needs of the other supply departments as well. The job of this organisation was the rapid repair of factories damaged by enemy bombing so that full production could be resumed with the least possible delay. In all the larger industrial areas, Panels were set up, composed of engineers, architects, industrialists, representatives of public service utilities, etc. All give their services free. There was little sleep for these men during the critical months of late 1940, and early 1941. The results of their labours are still apparent in the towns and cities that were hardest hit—in boarded walls and windows and tarpaulin roofs, under whose shelter the workpeople carried on with their tasks.

The second was the organisation which wrought marvels in the speedy dispersal of factories from highly vulnerable areas. It had long been settled policy to have more than one source of production for each separate item and component required by the aircraft industry, but the opening of the "Blitz" on this country showed that a much greater measure of dispersal was necessary and that, in many cases, it would be prudent to break up larger plants into smaller units. This policy was carried out with almost incredible speed and efficiency. The problem involved was not merely a physical one of transport of machine tools to a new district, but there were all the connected problems of the movement of the workers, with the attendant difficulties of billeting, housing and feeding.

We are never completely satisfied at the Ministry of Aircraft Production with the results of our efforts, but we do derive a little satisfaction from some of the things we have done. What we take most pride in is that we have been able to help the manufacturers, the designers and the workpeople in the aircraft industry. Between us we have not only maintained the technical superiority of equipment which enabled us to survive the Battle of Britain, but we have also reached numerical parity in the air with our principal enemy.

To this achievement the women of these islands have made an outstanding contribution. Hundreds of thousands of British women who have never been in a factory before are now engaged in making aircraft and scores of thousands are still being recruited each month, for we have not yet reached the peak of production. A large proportion of these women are married and they have to look after their homes as well. We are a small country; geographically we are smaller than the state of Oregon. Our people have lost all their luxuries and much of what, in times of peace, would be regarded as the necessaries of life. Thousands have been killed, thousands more have been maimed as a result of enemy bombing. Many thousands have lost their homes and many thousands more have foresaken their homes to move to other parts of the country where airplanes and their components are being made. Above all they have worked. They have worked to produce aeroplanes in quantities which, added to the flood now pouring out from the plants in the United States, will soon make our enemies rue the day when they set out to impose their barbarous domination upon the peace-loving peoples of the world.

END

Girl workers in an underground factory check component aircraft parts in a storeroom that was hollowed out of chalk.

BRITISH AIRCRAFT

by J. S. Buchanan

JOHN S. BUCHANAN, C.B.E., is Director-General of Aircraft Production. He is a Fellow of the Royal Aeronautical Society and also of the Institute of the Aeronautical Sciences (U.S.A.). He was born November 23, 1883, and attended the Royal Technical College, Glasgow, Scotland. In 1908 he was H.M. Inspector of Factories and later became a lieutenant commander in the R.N.V.R. Also a one-time squadron leader in the RAF, Mr. Buchanan later became Assistant Director of Research and Development of Aircraft at the Air Ministry. He was named a Commander of the Order of the British Empire in 1934.

IN 1939, Britain—since 1918 disarmed "to the edge of risk"—found herself at war with a country possessing the most powerful air force in history. True, Britain's newest fighters were better than any German type and her bombers were equal to or better than those of the enemy. This was in large measure due to the development of two things, the eight gun fighter and the power-operated gun turret. But the number of her aircraft was small and many aircraft even then obsolescent were still in service.

How well those British fighters and bombers fought and bombed has been told by others, and need not be referred to here: the object of this article is to describe how Britain has developed her aircraft since war began.

The British aircraft in France were *Hurricane* fighters, Army Co-operation *Lysanders* and *Battle* and *Blenheim* bombers. The bomber force based in Great Britain comprised *Wellingtons, Whitleys* and *Hampdens.*

At home there were also Gloster *Gladiators,* the last of the biplane fighters.

Here are some technical details about them as they were at that time:—

Gloster *Gladiator*	Maximum speed 250 m.p.h., four machine guns.
Hawker *Hurricane*	Maximum speed 335 m.p.h., eight machine guns.
Westland *Lysander*	Maximum speed 220 m.p.h., three machine guns and a number of light bombs.
Fairey *Battle*	Maximum speed 257 m.p.h., two machine guns, single engine, bomb load about 1,000 pounds for circuit of action of 1,000 miles.
Bristol *Blenheim*	Maximum speed 285 m.p.h., two machine guns, twin engined, bomb load 1,500 pounds for circuit of action of 1,000 miles.
Vickers-Armstrong *Wellington*	Maximum speed 250 m.p.h., six machine guns, twin engined, bomb load 4,500 pounds.
Armstrong-Whitworth *Whitley*	Maximum speed 245 m.p.h., six machine guns, twin engined, bomb load about 3,500 pounds.
Handley Page *Hampden*	Maximum speed 265 m.p.h., three machine guns, twin engined, bomb load 4,000 pounds.

These were the aircraft with which the Royal Air Force met the German blitzkrieg which burst over Holland, Belgium and France in May, 1940. On May 10, the British Advanced Air Striking Force in France had 135 bombers serviceable. During the following five days 75 of them were lost in action. By June 20, 40 per cent of the Force's total front-line strength had vanished. Its *Hurricane* squadrons supported by many more from Great Britain fought the Luftwaffe without ceasing and shot down scores of the German fighters and bombers.

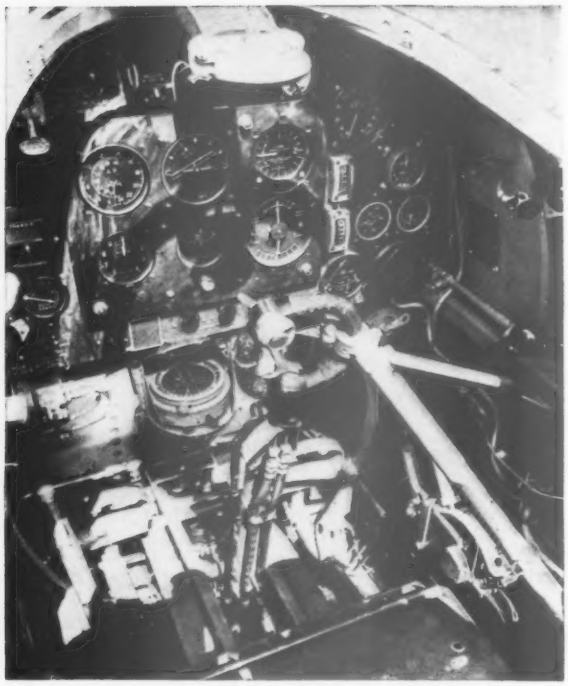
All the time the home based bombers had been thrown into the battle in attempt to arrest the German onrush. When the fighting neared the Straits of Dover home-based fighters lent their aid too. But the odds were too great. France was smashed, the British Army was evacuated from Dunkirk, the RAF squadrons flew back to England and the British people went to work in a fury of determination to redeem the military disaster which had befallen them.

While the Battle of Britain was raging in the skies above their heads, the factory workers toiled at producing the new aircraft with which Britain was to strike back. With bombs falling on their homes and workshops, the men and women of Britain stuck it grimly and got on with the job of restoring and increasing the strength of the RAF. They were beyond praise.

Now Britain has bombers more powerful than any Germany possesses. Types classed as "heavy bombers" two years ago have become "medium bombers," the *Blenheims*—then "medium"—are now "light," and the *Battles* have passed into his-

A nest of trouble for the enemy is this bomb bay of a four-engined Short "Stirling" bomber.

Giant Short "Stirlings" in mass production "somewhere in England." Assembly line in foreground is for wings and centre sections; fuselages are in line in background.



There are 40 instruments for the pilot to watch in the cockpit of a "Spitfire." Centre is control stick with gun button.

tory as have many other types of aircraft operating in 1939.

The *Hurricanes* and *Spitfires* of today are as different from those of the Battle of Britain as the new Curtiss P-40F from the original P-40, and there are newer types of fighters—such as the *Typhoon*—being built. The new "heavies" are the giant four-engined *Stirlings, Halifaxes* and *Lancasters,* carrying loads many times as great as those bombers which fought with such gallantry to stem the enemy attack in France.

World-famous aircraft designers such as Gouge of Short Brothers, Volkert of Handley Page, and Chadwick of A. V. Roe have done their work well. It is they who have produced these three tremendous bombers, it is they who will have done so much to bring Hitler to justice.

Glance again at the technical details of those early aircraft near the beginning of this article, and then read this:—

Short *Stirling*.....Four 1,600 h.p. Bristol *Hercules* engines, wing span 99 feet, length 87 feet, 3 in., height 22 feet, 9 in., gross wing area 1,460 square feet, loaded weight 70,000 pounds, maximum speed at 14,000 feet nearly 300 m.p.h. Maximum bomb load eight tons, crew of seven, two guns amidships in upper turret, four guns in tail turret.

Handley Page *Halifax*.....Four Rolls Royce *Merlin* engines of 1,175 h.p., wing span 99 feet, length 70 feet, height 22 feet, mainplane area 1,250 square feet, loaded weight 60,000 pounds, maximum speed approximately 300 m.p.h. Maximum bomb load five and one-half tons, crew of seven, two guns nose turret, two guns midship turret, four guns tail turret.

A.V. Roe *Lancaster*.....Weighs 30 tons. The fastest and deadliest bomber for size and bomb load in the world. Carried out the famous daylight raid on the submarine engine works at Augsburg, which so surprised the Germans.

The *Wellington* now is fitted with Bristol *Hercules* engines of far greater horsepower than before; its speed has therefore greatly increased and its general performance remarkably improved. So much so, indeed, that its latest performance may not be quoted here. This is one of the most consistent bombing aircraft in any air force, Allied or enemy, and—thanks to its geodetic construction—a most difficult plane to shoot down. It has fought in almost every campaign since the war broke out, in all sorts of conditions, and has stood up to them all with a competence and sturdiness which has justified the work of R. K. Pierson, who designed it.

The *Manchester*—designed by Chadwick of the A. V. Roe Company—was for a time the fastest and most powerful twin engined bomber flying for the RAF, but there is little point in describing it in detail as it is being superseded by the *Lancaster.*

Among other heavy planes flying with the RAF is the Short *Sunderland* flying boat, a type which has flown thousands of miles for the British Coastal Command. Powered by four Bristol

(Continued on page 258)

Stored aircraft sections are identified for "Wellington" bombers by their geodetic construction.

AMERICAN AIRCRAFT IN THE RAF

Beginning of the fourth year of war finds U. S. aircraft playing a decisive role in all RAF operations.

ON the day that Britain declared war on Germany—September 3, 1939—squadrons of RAF Coastal Command aircraft set out in search of U-boats and Nazi shipping. They formed the spearhead of a great offensive which has continued without respite for nearly three years. Lockheed *Hudsons*—known affectionately as "Old Faithful" throughout the RAF—were out with Coastal Command on that fateful day, and they were the first American designed and built aircraft to have a crack at the Hun. Before the war was a month old a Lockheed *Hudson* had its first encounter with a U-boat. They can now claim to be the first American aircraft to take part in a thousand-bomber raid on Germany—hunting U-boats at their base at Bremen, instead of on the high seas.

As far back as June, 1938, the British Government recognised the high qualities of American aircraft and placed orders in the United States for several hundred planes for reconnaissance and advanced training duties, and the following year Lockheed *Hudsons* began to arrive for Coastal Command.

Primarily intended as a reconnaissance plane, the *Hudson* has proved its versatility by turning bomber or fighter as occasion has demanded. Its striking power has been felt from the Arctic to the swamps of Malaya. A *Hudson* found the prison ship *Altmark* slinking back to Germany with nearly 400 British seamen aboard. In August, 1941, a *Hudson* made history by capturing a German U-boat. *Hudsons* fought over the Dunkirk beaches and escorted British ships home after the *Bismarck* had been sent to the bottom. When the yellow hordes swarmed on to the Malayan beaches, it was "Old Faithful" which struck the first blow.

Night after night the new Mark V's powered by Pratt & Whitney *Twin Wasps*, patrol the enemy occupied coastlines, harrying Nazi shipping. "It is one of the most reliable aircraft we've ever had in the RAF," is the summing up of the Lockheed *Hudson* by a seasoned RAF pilot.

Another established favourite at Coastal Command is the Consolidated *Catalina*, PBY-5's in the U. S. Navy.

The "*Cat*" hit the headlines when it spotted the *Bismarck* and was instrumental in bringing the warship to battle and ultimate destruction. It was a "*Cat*," too, which guarded the U-boat which surrendered to the *Hudson*. The Consolidated *Liberator*, sister-ship of the "*Cat*," is now operating with Ferry Command. A *Liberator* recently made a non-stop operational flight of 2,800 miles. With one stop for refuelling it completed the trip of 5,000 miles in 23 hours. Two *Catalinas*, piloted by Dutch naval pilots, also flew 2,800 miles non-stop from Australia to Colombo recently.

The Martin *Maryland*, direct descendant of the twin-engined bomber of 1918, is a veteran of the Libyan campaigns. What the *Halifaxes*, *Stirlings* and *Wellingtons* have done and are doing to Germany's industrial targets, the *Marylands* have done to Benghazi, Derna and others of Rommel's strongholds. In November, 1941, a *Maryland* patrolling the Mediterranean sighted an enemy convoy of 11 ships. Units of the Royal Navy were directed to the spot and within a few hours most of the convoy had been sent to the bottom. The Martin *Baltimore*—known as the "Flying Torpedo"—is now following in the Maryland tradition.

The Douglas factory at Santa Monica, Calif., is striking hard at the heart of Germany's war effort in Occupied France, as well as at vital points in Libya. The *Boston III* figures almost daily in Air Ministry communiqués. On March 8 this year a formation of these bombers led the daylight attack on the Matford Works at Poissy, till then producing 20 lorries a day for the German army. The docks at Calais, Cherbourg, Boulogne and Le Havre—as well as the Le Trait shipbuilding yards on the Seine—have all felt the weight of *Boston* attack.

RAF pilots speak highly of the *Boston's* performance. They are handy, fast on the controls, and can stand up to heavy punishment. Powered by Wright *Cyclone* engines, these *Boston III's* are developed from the Douglas DB-7—a pioneer type of medium-sized bomber built by America for France a few years ago.

The Douglas *Havoc* night-fighter is a close relation of the DB-7 and has won high regard from British and Dominion air crews. With the Boulton Paul *Defiant*, *Havocs* rank as Britain's "Night Commandos" of the air. Combining the speed of a *Hurricane* with much greater endurance, these nighthawks have taken heavy toll of German bombers over Britain in the last 12 months, as well as ambushing the returning raiders over their own aerodromes.

In the battle of the desert and in the Far East, American aircraft have achieved enduring fame. For obvious reasons it was simpler to send American-built aircraft direct to Libya, although this meant diverting to another front aircraft which would have been welcome in Britain. The soundness of this policy has never been in doubt. *Tomahawks*, *Kittyhawks*, *Marylands*, *Martlets*, *Mohawks*, *Bostons*, *Flying Fortresses*, *Catalinas*—planes representing all that is best in American design and workmanship, are playing their vital role in the great struggle, flown by pilots of all the free nations.

The Curtiss *Tomahawk*—fittingly so-named from the American Indian word to "knock down"—has a long list of victories to its credit, dating back to the early days of the Libyan battles. Before France fell, a deadly little American fighter appeared on the Western front. It was called the *Hawk*. Fitted with a more powerful Allison liquid-cooled motor it reappeared, first in Russia and then in the Middle East, as the *Tomahawk*. In one of their first major engagements these fighters destroyed 12 Axis aircraft. Me-110's, Ju-88's, Fiat G-50's, Cant 1007's—every type of German and Italian plane has learned the fighting quality of the little *Tomahawk*.

Following close on the *Tomahawk* came the Curtiss *Kittyhawk*. It has figured in nearly every RAF communique from Cairo since it took its place in the front line early this year. Fitted with a 1,325 h.p. Allison V-1710 12-cylinder liquid cooled-motor, it has reported top speed of about 380 m.p.h., carrying six machine-guns in its wings. A few weeks ago a Curtiss fighter squadron scored a spectacular success by shooting down 13 Ju-52 troop-carriers and two Me-110 fighter-bombers. In this one engagement the *Kittyhawks* sent to their doom 15 Hun aircraft and from 200 to 250 men. Besides escorting Douglas *Bostons* on bombing raids, *Kittyhawks* are bombing and ground-strafing enemy positions and troop and M.T. concentrations.

Nearly a year has passed since bombs were dropped for the first time by Boeing *Flying Fortresses*. On July 24, 1941, they took part in the great daylight attack on the battleships *Scharnhorst* and *Gneisenau* sheltering at Brest. They flew at such a height that they could not be seen or heard from the

(*Continued on page 274*)

Fitting one of two Rolls Royce "Merlin" engines into an Armstrong-Whitworth "Whitley" bomber.

ENGINE PRODUCTION

Wartime demand has been met by the expansion of Britain's major aero-engine firms and the development of "shadow factories" to augment them.

by F. R. Banks

GROUP CAPTAIN F. R. BANKS, O.B.E., is a specialist in aviation fuels. From 1930, until the outbreak of the war in 1939, he held the position of technical manager and chief engineer of the Ethyl Corporation (later the Associated Ethyl Co.). Group Captain Banks began his engineering apprenticeship when 13 years of age. He served during the entire period of World War I in the Royal Navy in mine-sweepers, submarine chasers and motor torpedo boats. After the war, he specialised in marine Diesel engines, and subsequently became the chief experimental engineer with a well known aero-engine firm. He now directs aero-engine production for the M.A.P.

THE directorate general of engine production in the Ministry of Aircraft Production is responsible for ensuring that adequate capacity is available for the manufacture of engines, to meet airframe requirements. In planning this capacity with the various aero engine manufacturers, due account has also been taken of the need for spares—in terms of complete engines and also "bits and pieces."

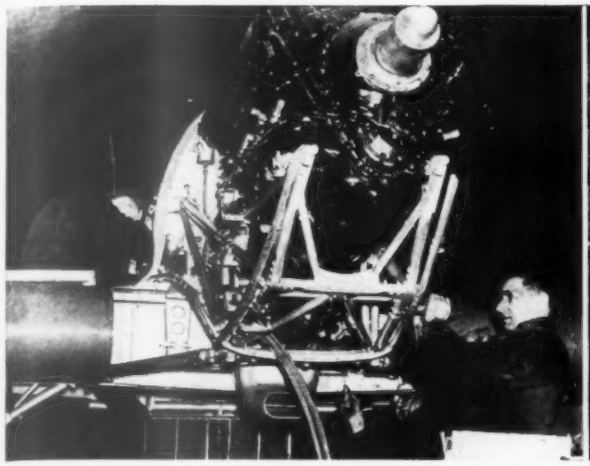
This may mean, in the case of an entirely new engine, completely new jigging and tooling together with the provision of additional and, perhaps, special purpose plants or, if the engine to be produced is another version (or "mark") of an existing type, only particular jigging and tooling for the altered or new parts.

However, before all this happens, a great deal of development work on the new model will have been done by the firm concerned; in order to see whether, in the first place, the engine will give the improved performance expected of it and to force the pace if it doesn't and, finally, when this improvement is obtained—be it higher take-off power and greater power at altitude or better specific fuel consumption—whether the new engine is reliable.

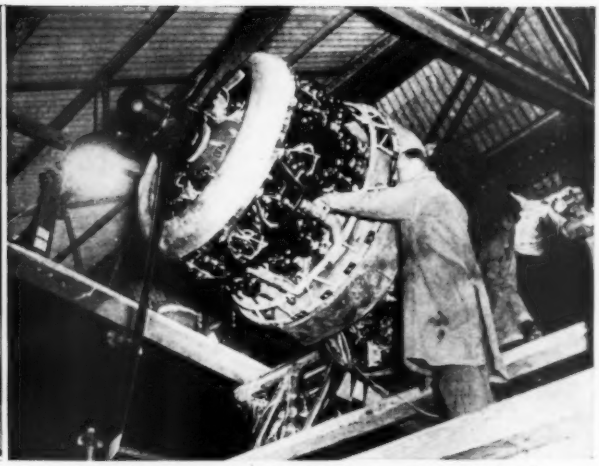
It cannot be said too often that, in the particular case of the aero engine, development *is* production. It is only by intensive development that a successful engine can be put into full production uninterrupted (relatively) by modifications. Of course many modifications have to be faced, but major modifications, which are due to lack of, or ineffective, development have a disastrous effect upon production.

It pays the parent engine firm to have a large development department with plenty of machine tools and adequate test equipment; and a capable staff with someone with foresight at the helm who is in direct contact with those who use his firm's products. In addition, there must be a large staff of capable installation engineers whose job it is to go out into the field and supervise the handling of the new engine.

The production organisation of the large aero engine forces has often been criticised; it is said that they could produce many more units with a better shop layout. Their critics are usually ignorant of the evolution of the average high-duty aero engine and cannot see that in the past and prior to the war most of these firms were just one big development department with few special tools and many general purpose



The V-shaped Rolls-Royce "Merlin" engine of nearly 1,200 h.p. being fitted to the RAF Hawker "Hurricane" fighter.



A Wright "Cyclone" being fitted to a Short "Stirling," one of the RAF's most formidable four-engined bombers.

ones. And that they were, and still are the places in which engines are born. Their job is to nurse these engines through their teething and growing pain periods.

The demands of war are such that it is often necessary to introduce quickly and, of necessity, in limited numbers, an engine of improved performance to fit an existing type of aircraft. It is then that the value of the firm having a large and efficient development section is appreciated. How many times lately have we been thankful for such a firm!

Since the close of the last world war there has been a small but robust group of companies in Great Britain designing and manufacturing high quality aero engines. And even in the lean years that the British aircraft industry has faced on different occasions since 1918, the air staff was able to keep the chief aero engine firms alive. Both this policy and this fact have been of inestimable value to British aircraft designers who were thus assured of the advantage and co-operation of an efficient and progressive sister industry.

British aero engines have kept abreast of world design and they have undoubtedly influenced foreign design considerably as well as being licensed for production abroad.

The number of designing and production forces can be counted on the fingers of one hand; they are generally known as the parent firms. The three principal forces are Bristol, Rolls Royce and Napier.

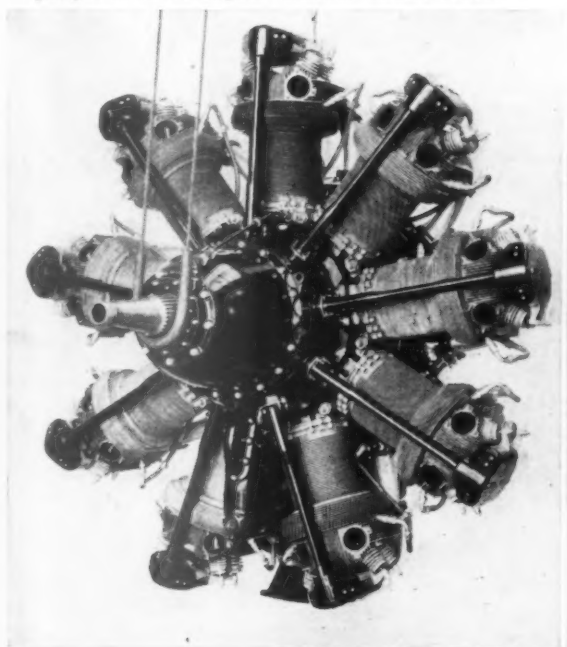
In order to meet war requirements, the parent aero engine firms have been expanded and other factories have been built to manufacture their engines on a production basis. The latter, naturally, are not concerned with development—only production. They are, in some cases, managed by the parent firm and in others are staffed, managed and run by a number of famous British automobile manufacturing concerns.

These plants, in most cases, are known as "shadow factories" but they are, in fact, large Government-owned factories managed and run for the Ministry of Aircraft Production by industry.

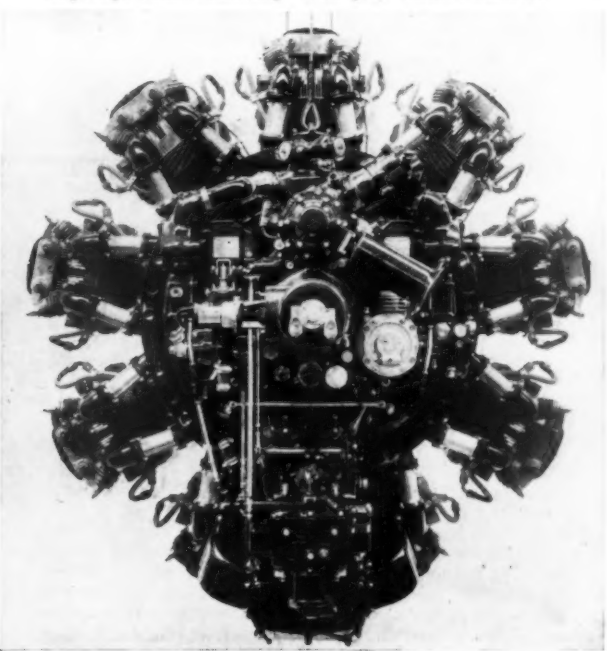
The history of British aero engine production in this war will be written some day and it will have a deservedly high place in the annals of engineering.

(*Continued on page* 236)

The Bristol "Mercury" nine-cylinder poppet-valve radial engine powers the twin-engined "Blenheim" medium bomber.



The Bristol "Pegasus" 1,000 h.p. engine that powers the long-range Vickers-Armstrong "Wellington" medium bombers.



ARMAMENT PRODUCTION

Two of the four 20 mm. cannon on a Hawker "Hurricane II" fighter.

by

J. W. Mills

MR. J. W. MILLS, O.B.E., DIRECTOR OF ARMAMENT PRODUCTION, MINISTRY OF AIRCRAFT PRODUCTION, formerly managing director Halley's Industrial Motors. Has held managerial posts with Humber, Coventry Climax Engines, Sunbeam Motor Co. and Austin Motor Co. Mr. Mills has made frequent visits to the United States and to leading production centres on the Continent. He is a member of the Institute of Automobile Engineers of Great Britain and of the Society of Automotive Engineers in the U. S. A.

MOST people think of aircraft armament in terms of guns and bombs. In practice it covers an enormous range of equipment from complicated gun turrets to fuses, as well as a number of weapons. Upon its quality and disposition depends the offensive and defensive efficiency of the aircraft.

Supply of this highly important material to the Royal Air Force is undertaken by the directorate of armament production in the Ministry of Aircraft Production and by the Ministry of Supply. Research into and development of all kinds of aircraft armament is undertaken by other departments of the M.A.P. But although armament covers many types of equipment, the main problems must, of course, always be the adequate supply of the right kind of guns, power-operated gun turrets, ammunition and bombs.

On the outbreak of war in Europe nearly three years ago the air defence of Britain was dependent upon the eight-gun fighter. The Secretary of State for Air, Sir Archibald Sinclair, during the height of the Battle of Britain described its adoption as "one of the greatest decisions in the history of war."

This article appears at a time marking the second anniversary of the defeat and rout of the Luftwaffe in their major daylight attacks upon England. That was in 1940. But it was seven years earlier that the eight-gun fighter was conceived; a tribute to the men who foresaw the need for a fighter of superlative quality if the bomber of the future was to be defeated.

For all practical purposes the eight-gun fighter can be traced to a blue foolscap minute in a red-covered secret Air Ministry file. That was on April 4, 1933. It was signed by the late Wing Commander A. T. Williams.

Consideration was being given to the replacement of the Hawker *Fury* and the Bristol *Bulldog* fighters with a biplane mounting four, six and eight guns. Because the estimated performance figures set out in that minute were not far enough in advance of what aircraft then building could do, the project was temporarily dropped.

One objection to the extra armament was that it would have the effect of making the aircraft too slow. But the advent of the low-wing monoplane made possible the mounting of all eight guns within the wings—four in each. Also, because the guns would be firing clear of the airscrew, synchronisation mechanism for firing through the airscrew was no longer necessary.

Air Vice-Marshal R. S. Sorley, then a squadron leader, predicted that the extra guns would mean the loss of only one m.p.h., an extra four seconds in the time taken to reach 20,000 feet and an operational ceiling of only 1,000 feet less. Of course these figures have no relation to present-day performance.

Experts, therefore, decided that these slight losses in performance were more than counter-balanced by the increased fire power. The issue was complicated by the development in France of a cannon gun. It was claimed that only one hit from this gun would prove fatal to any aircraft. This gun, however, was in its infancy and had the disadvantage of having to be mounted on the engine and fired through the airscrew boss to secure sufficient rigidity.

In November, 1934, the eight-gun fighter was decided upon. Monoplanes, later to become the famous *Spitfires* and *Hurricanes*, were then on the drawing board. It must be recorded that much of the credit for the development and ultimate adoption of the eight-gun fighter must go to the late R. J. Mitchell of Vickers Ltd., creator of the *Spitfire* and to Sydney Camm of Hawkers Aircraft Ltd. designer of the *Hurricane*.

The original *Spitfires* and *Hurricanes* were equipped with the Browning .303 gun. The latest and vastly improved types are fitted with cannon guns capable of firing three times the former weight of ammunition.

The Browning was developed from the U.S.A. Colt gun, being modified for the RAF in Great Britain. Together with the Vickers gas-operated "K" gun, they were the principal weapons in use in RAF aircraft on the outbreak of war. Production has been enormously expanded and the Browning gun is now being turned out in immense numbers each month in Britain and Canada.

Royal Air Force aircraft in September, 1939, had two important advantages over German warplanes—protective armour including bullet-proof glass and the power-operated gun turret. The war had been in progress more than six months before the Luftwaffe developed effective armour for its pilots and vital parts of the aircraft.

How well our pilots were protected even in those early days of the war can be judged by the following story. A Coastal Command Lockheed *Hudson* aircraft had been on reconnaissance over enemy territory and had had a successful engage-

ment with Messerschmitt fighters. When the British pilot landed he complained of a splitting headache. He said that he had never suffered from one before and was very disturbed. He was asked if his aircraft had been hit and he replied, "No." But when mechanics were examining his machine they discovered a huge dent in the armour shield behind the pilot's head. His aircraft had been hit by a burst of machine-gun fire. The armour had not only saved his life but had afforded such protection that he hadn't known a thing about it.

The Germans, however, while slow in adopting armour had made considerable advancement by the time they went to war with self-sealing petrol tanks. They were using with great efficacy a rubber compound spread over the metal surface of the tank. When hit by a bullet, the hole immediately sealed up.

At first, the RAF used armour for protecting the petrol tanks, although experiments had been in progress with a self-sealing type long before the war.

It became obvious, however, to both sides that although the eight-gun fighter had a devastating fire power, spitting out its bullets at the rate of 10,000 a minute, the cannon shell was necessary to penetrate the new protective armour.

The development of the 20 mm. shell firing gun, popularly known as the cannon, had been in progress in Britain, as well as France and Germany, before the war and small quantities were being produced. The Hispano Suiza type, which had been selected by the RAF, had many teething troubles which were gradually overcome, and for some time now it has been in large-scale production, incorporating a continuous shell-feed mechanism, both in Britain and America.

Provision of ammunition for the RAF is solely the responsibility of the Ministry of Supply, and this department also meets the requirements of the Navy and Army. Vast quantities are being produced in Britain, the United States and Canada and are allocated by a special Anglo-American supply committee.

As stated above, nearly all British bombers when war broke out were equipped with power-operated turrets mounting a

Four .303 machine guns bristle from the formidable Frazer Nash tail turret of this Short "Sunderland" flying boat.

Bristol "Beaufort" turret with single .30 calibre gun. This type of turret was first introduced in the "Blenheim."

battery of guns. German bombers, besides being under-gunned, did not have this advantage. In consequence they were particularly vulnerable when attacked by fighters.

The RAF and the Luftwaffe had followed contrary policies. As the result of experience gained during the Spanish civil war, the Germans came to the conclusion that a bomber's best defence was speed. This, however, was a wrong decision because it was based on a faulty premise. Fighter opposition in Spain was negligible and the quality of the aircraft being used was not up to the standard likely to be experienced in a war between major powers.

In honesty to the German Air Staff, it must be stated that they were unaware of the great progress made in Britain in radiolocation—probably the determining factor in the Battle of Britain. True we possessed fighters of superior speed and fire-power, flown by pilots with indomitable courage, but there was insufficient margin of speed between the British fighter and the German bomber to be really the deciding factor without the scientific aid of knowing where the bomber was and so placing the fighter in the best position to intercept it.

But the Heinkel He-111 and the Dornier Do-17 did suffer heavily because they were unable to adequately protect themselves. So our *Spitfires* and *Hurricanes* shot them out of the sky in great numbers even when the Luftwaffe tried vainly to protect its huge bomber formations with hordes of Messerschmitt fighters.

British bombers have always been heavily armed, it being contended by the British Air Staff that a bomber should be capable of fighting its way to the target. This has proved sound policy, our day and night bombers often coming out best when attacked by fighters. During a mass raid on Bremen in June this year a *Stirling* shot down three out of five Messerschmitts and arrived home safely.

The early types of gun turrets were hand-operated. The power-operated turret was an important advancement because it would be physically impossible for a gunner to traverse a hand-operated turret in an aircraft flying at present-day speeds.

British firms—the Bristol Aeroplane Company, Nash and Thompson and the Boulton Paul Aircraft Company—have been in the vanguard of the development of these turrets for carrying single and multi-guns with high ammunition capacity.

The first Bristol turret was developed in 1935, and the type was accepted for use in the RAF in the *Blenheim* medium bomber. It is electric-hydraulically controlled. Today this turret is in daily operation against the enemy in *Blenheims*, *Beauforts* and other types.

Large-scale production commitments of aircraft and engines have made it necessary for the Bristol company to pass on manufacture of these turrets to other famous engineering companies.

This is the blister gun position in a Bristol "Beaufort" torpedo bomber. The gun fires backward, covering the tail.

The four-gun, power-operated turret is one of the most formidable weapons yet devised by the RAF. That shown here is mounted in a Boulton Paul "Defiant." It was because of this turret that the "Defiant" scored so heavily over Dunkirk.

The two other main types are the Frazer Nash and the Boulton Paul.

Power for the Frazer Nash turret is derived from a pump incorporated in the engine which supplies oil under pressure to a high efficiency oil motor which rotates the turret. Elevation and depression of the gun is effected by pressure operated rams and the gun controls are centralised, similarly to those on the handlebars of a motorcycle, for ease of manipulation.

The Boulton Paul turret is also characterised by its electro-hydraulic operation; power being supplied from an electric generator driven by the engine. An electric motor in the turret coupled to an oil pressure pump rotates the entire turret and its guns. The controls, in this case, are centralised and rather resemble a pilot's "joy-stick."

Turrets must also incorporate all the ancillary services which the gunner finds necessary, such as electric lighting, oxygen supplies and telephone communication with the pilot and other members of the crew. A very high standard of efficiency is obviously essential.

At the outbreak of war, the RAF had large stocks of bombs ranging in size from the small 20 and 40 pound anti-personnel bombs for use in co-operation with the Army to large high explosive bombs for use against industrial areas and shipping. These have developed in size and power.

Bomb requirements vary a great deal. They are needed to blast large areas, for the penetration of buildings and deep-seated targets, for the piercing of ships and the armour-plating of battleships.

Manufacture is on mass-production lines, either by casting or forging processes. The big high capacity bombs are, however, too large to be made in one piece by either process and are formed of composite structures of immense weight.

Incendiary bombs which are also manufactured in immense quantities are of two main types—the cast magnesium bomb and the case bomb filled with inflammatory composition. The requirements of magnesium metal for filling the first type has entailed the erection of large metal producing plants specially for this purpose.

Production of components to match that of bomb bodies is also a problem of considerable magnitude, especially in the case of the larger bombs for which several sets (in some instances five) of explosive parts are necessary.

Equipment to produce these necessitates the very latest type of machinery, much of which is semi-automatic or fully automatic. Fabrication has been modified to enable automatic types of welding to be used.

END

RESEARCH AND DEVELOPMENT

This branch of the Ministry of Aircraft Production is one of the most important. Each development may mean an important victory.

by J. Linnell

AIR MARSHAL FRANCIS J. LINNELL, C.B., O.B.E., is Controller of Research and Development in the Ministry of Aircraft Production, and a member of the Air Council. He joined the R.N.A.S. in 1914 and served throughout the last war in France and with the Royal Navy. He was named an air commodore in 1939, air vice-marshal in the same year, then assistant chief of the Air Staff. For the first 18 months of the present war, Air Marshal Linnell was Air Officer in charge of Administration in the Bomber Command. He has held his present post since 1941. He received the Order of the British Empire in 1923, was made Companion of the Bath in 1941.

AIRCRAFT production is a major key to victory. But it is not enough merely to produce aeroplanes, even in hundreds of thousands so that they darken the enemy's skies the world over. The enemy tried darkening *our* skies. Much good it did him.

Quantity is not enough. A war of machines is a war of brains and victory goes to the side whose brains are the best. By the end of the 1914-1918 War, the Royal Air Force had flown the German air force out of the sky—not because of any lack of numbers or even of flying skill or bravery on the part of the Germans, for their pilots did not lack courage, but because the Royal Air Force was given better aircraft to fight with—in other words because our research work and designing were superior to theirs.

In this Second World War, history has repeated itself. The biggest air force in the world flew against the British Isles in the autumn of 1940. Thousands upon thousands of the finest aircraft Germany possessed, met in combat over England a force of British fighter planes so small in number that the watching world was afraid that there could be only one result.

But by the end of the Battle of Britain, 2,375 German aircraft had been shot to pieces. And even allowing for the marked superiority of the British fighter pilots, it is unlikely that they could have achieved such results had not their aircraft been better than those of their opponents.

The responsibility of the Ministry of Aircraft Production's Controller of Research and Development covers aerodynamics, instruments, engines, fuel types, guns, bombs, materials, propellers, investigation of the many ideas and inventions submitted, and all other aspects of aircraft improvement.

The organisation of the controller's department need not be described in detail. Broadly, the work is divided, under the controller, between four directorates: Scientific Research, Technical Development, Engine Development and Armament Development.

But all research and development is not concentrated in one small departmental circle. All ideas are pooled, all brains are in contact—from the aircraft designers and experts employed in the aircraft industry itself, to the Aeronautical Research Committee of independent scientific specialists which helps and advises the Ministry of Aircraft Production, and the Royal Aircraft Establishment which helps and advises everyone.

For obvious reasons not much can be said of the Directorate of Scientific Research which is not irritatingly nebulous and discreet. There is little drama in its work. The layman who visualises it as capable of inventing overnight secret weapons which will stagger the enemy in the morning is a romanticist. Research is often slow to produce results, but is nevertheless overwhelming in its culminating effect.

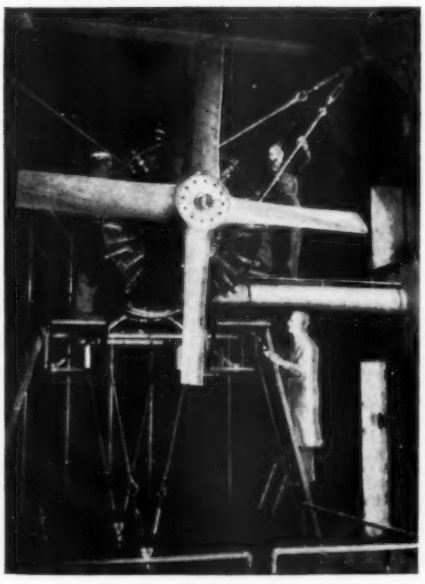
In peacetime, the results of scientific research the world over are shared. In wartime, opposing scientists are engaged in a death struggle behind the scenes. And as in this war, Germany has always failed to beat the British and American scientist. It is true that this is not the popular view, that we are forever stumbling after the Germans along the paths they have so brilliantly pioneered, but in reality we are, in general, keeping steadily in front of them.

That is not wishful thinking; it is fact. There is nothing which Dr. Seewald, head of Hitler's principal aeronautical research institute, has devised to date which has surprised or outwitted the Directorate of Scientific Research of the Ministry of Aircraft Production. But we have given Dr. Seewald many surprises, and more are on the way.

This directorate both receives and distributes ideas. More than the others, it is advised by the Aeronautical Research Committee, which is similar to the National Advisory Committee for Aeronautics in the United States. It helps and is helped by the aircraft designers and expert research makers of the aircraft industry, and works closely with the Royal Aircraft Establishment. It investigates thoroughly and honestly every invention, every idea submitted to it from the outside world.

This, in itself, is a task which takes up the full time of a staff of 30 men and women. At the height of the German bombing of Britain, 40,000 inventions were suggested to the directorate every month. That is at the rate of nearly half a million a year, or over a thousand a day. Yet everyone

This engine is undergoing test by M.A.P. engineers, after its initial running-in.



After being shot down by an RAF pilot, this Junkers Ju-88 is being carefully reassembled for experimental purposes.

with an idea which might contain even the germ of something useful was assured of a fair hearing.

Some of the ideas were good: some, to put it gently, were not so good. Yet everyone was patiently examined. The woman who assured the directorate that, if it adopted her formula for night glasses, our night fighters would shoot the attacking German bombers out of the sky in hundreds was politely informed that her formula of "176 grains finely crushed horn from hoof of cow or bullock, 60 gr. prepared white chalk, 4 oz. distilled water, 1 oz. ether, 3 oz. glycerine, 2 teaspoons oil of Juniper, 7 drops cucumber juice, 1 white of egg. Mix as specified. Boil 2 minutes. Strain. Bake at 450 degrees till set firm" had been gratefully noted and would be borne in mind for future reference.

The man who suggested that all aircrews should have their palms read by a skilled palmist and that those whose palms showed that they had not long to live should not be allowed to form the complete crew of one aeroplane, received a similarly courteous acknowledgment.

So did the man who insisted that we should create a new North Pole and throw the compasses of enemy aircraft into well-merited confusion; and the equally ingenious citizen who hammered home the point that our night fighter pilots would receive inestimable assistance in the detection of enemy aircraft if only the directorate would admit the wisdom of including a caged owl in every cockpit.

To write anything more of the many activities of this directorate is impossible. There is nothing of real interest which can be published here or anywhere about its work without endangering its secrecy. The most evasive and guardedly phrased hint of the many ways in which its activities are at this very moment perturbing and puzzling the German High Command would easily—indeed, certainly—provide the enemy with a clue. It is a pity that not even an inch of the curtain which blacks out the directorate's work may be lifted. If it could be lifted, you would be more than interested—you would be vastly encouraged.

The Directorate of Technical Development deals with all the engineering problems associated with the design of aircraft and equipment for the Royal Air Force and the Fleet Air Arm. The work ranges from the control of the development of all classes of material used in aeroplanes to the development of highly complicated bombsights, automatic controls, and the like; from the provision of technical literature describing equipment and giving maintenance instructions to the development of flame damping and other essentials for effective night flying; from the development of electrical generators, motors and installations to the technical investigation of accidents. The directorate also acts as a consultant to the Air Staff on the design of aircraft to meet new requirements.

Its work consists for the most part of technical administration, the actual work of design being done at the main aircraft firms, at instrument and electrical works and at Ministry of Aircraft Production outstations. Sound business management, with technical discussion and criticism as the background, enables the directorate to guide industry along the right lines.

The section dealing with installation of equipment is manned almost entirely by service officers who do their work very largely "in the field"—mainly at the firms. These officers supply "user" knowledge, advising the firms as to how equipment can best be placed and fitted. They thus hold the balance between the various specialists, through a sense of proportion

This twin-engined Messerschmitt Me-110 fighter, now bearing RAF markings, is used for comparative flight tests with British and American aircraft. It was shot down in England and then repaired.

which has been derived from first-hand operational experience.

The principal outstation is the Royal Aircraft Establishment which has already been referred to. Headed by a director, this station forms a consultative and design organisation not only for the Ministry of Aircraft Production but for the whole aircraft industry.

Employing some hundreds of experts, the establishment is responsible not only for the whole field of research on aircraft, engines, and equipment, but it also initiates the design and development of special items such as automatic controls, bomb-sights, and electrical and wireless equipment.

Another outstation is exclusively devoted to aircraft testing. Here all new types are thoroughly tried for performance, basic suitability and safety at high speed. At this station also electrical equipment and all types of installation including armament and bomb gear are tested.

A third outstation confines itself entirely to the testing of the big flying boats.

At each of the main contractors' works representatives of this directorate are stationed to work with the firms in the interpretation of Air Staff operational and headquarters engineering requirements and to give decisions on detail on the spot.

The firms are responsible for the design of the aircraft.

M.A.P. engineers prepare a model wing for testing in the wind tunnel. New designs, however, come from manufacturers.

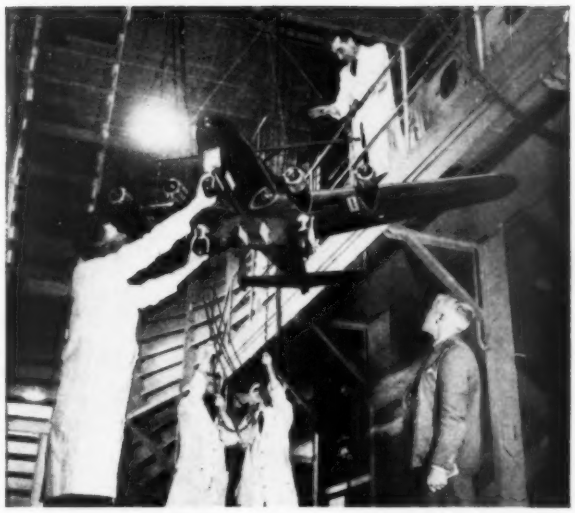
They have their own engineering organisation which is approved for design work by the Ministry of Aircraft Production. The directorate ensures that the combined experience of all firms is made available to each of them individually. When trouble arises, especially during the early life of an aircraft, or in accidents, the firm, the R.A.E. and other experts likewise combine their resources to find a solution as rapidly as possible.

Technical developments fall naturally into two categories:

Intensive development of existing equipment and the initiation of new designs. It is better to concentrate on the development of existing types if technical superiority can be retained in this way since this causes less disturbance in production. For this reason new designs are not started unless great advances in performance can be obtained.

Naturally, many operational demands arise in war time. A notable example was the provision of armour protection for the crew and vital parts of aircraft, and the self-sealing device for fuel tanks. These necessitated a great deal of research, but the problems were solved and efficient protection given to all service types engaged in operations.

The effective evolution of a new type of engine from its conception on the drawing board to full production occupies from four to five years, with many thousands of hours of test bench running and preferably many hundreds of hours of experimental flight. New types of engines are usually developed through the foresight of the engine designing firms, and the Directorate of Engine Development, acts as a working partner



This scale model of a new four-engined aircraft is being hoisted into the wind tunnel for exhaustive airflow tests.

to the engine industry in enterprise and intelligent prophecy.

The stage of quantity production and use by the Royal Air Force of the new type engine is followed by many years of further development leading to later "marks"—improved versions—of the original model. In this work, the directorate—always in full partnership with the industry—is concerned with the constant study of defect reports received from the Royal Air Force on the earlier "marks," and with the increasing demands of operational performance from the aircraft employing the type of engine.

It is as difficult to write of the Directorate as of Scientific Research, for the Germans would give a great deal to know about the development of newer and better armament and bombs for British aircraft. Its object is, briefly, to develop to the maximum both the offensive and defensive power of the RAF. The bombs now dropped daily and nightly on enemy territory are infinitely more crushing than those dropped 12

(*Continued on page 273*)

Another view of a wind tunnel model. This monoplane model will undergo exhaustive tests before the type is accepted.

The wrecked fuselage of a German bomber being broken up for scrap provides a fitting frame for this salvage crew.

SALVAGE

by C. W. Weedon.

Crashed aircraft are no problem for this hard working group of artisans, who comprise Repair and Maintenance service.

AIR COMMODORE C. W. WEEDON, DIRECTOR OF REPAIR AND MAINTENANCE, MINISTRY OF AIRCRAFT PRODUCTION, enrolled at the Royal Naval College at Osborne in 1915. He transferred to the Royal Air Force Cadet College, at Cranwell, in 1920, and upon completion of his course was graduated as First Pupil and as Senior Cranwell Cadet. In 1932, he was awarded an Honours Degree in engineering at Cambridge University. Air Commodore Weedon attained his present rank of Air Commodore in 1941, and, at 39 years of age, was selected to direct the important service of Repair and Maintenance.

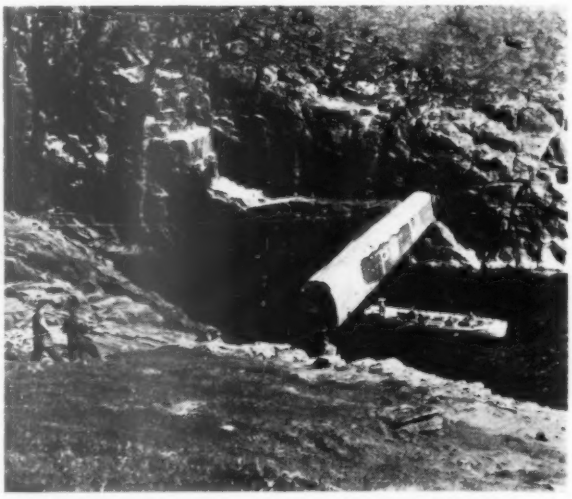
A CRASHED aircraft has not necessarily completed its useful life. If it is our own, much can be salvaged; if it is an enemy machine, much can be learned. Damaged aircraft can sometimes be repaired on the site, or at least transported to a repair depot and made to fly again. But even if damaged beyond possibility of repair they may still contain a great quantity of serviceable or repairable components, or provide valuable raw material.

The crashed enemy plane is obviously the concern of the Air Ministry Intelligence Branch. No matter how inaccessible the site, an intelligence officer is soon on the spot and together with technical experts studies the wreckage in the case of a known type for any improvements in design or, if it is an altogether new type, for any novel features demanding the development of countermeasures for use by the Allied Air Forces. Thus, salvage is of vital importance both as a source of raw materials and as an aid to research and development. The R.A.F. Maintenance Group which (under the control of the Ministry of Aircraft Production) is responsible for it, has made it a fine art.

First among the maxims of the group is speed of collection; speed not only from the point of view of rapidly clearing the site of a crash—which may be of paramount importance when a road or a railway line is obstructed—but also from the point of view of returning to active service the aircraft, or such component parts as are available, with the least possible delay.

A Messerschmitt Me-109, shot down by the RAF in England, will be exhibited to swell a local "Spitfire" Fund.

More than 60 feet long, these salvage trailers can carry a complete fighter aircraft or sections of large bombers.



The fuselage of an RAF bomber which crashed in this rocky canyon is being lowered to a cutter by a salvage mission.

Every crash is reported to the group and, within a few hours, an engineer officer is on the job. His is the responsibility for assessing the damage and deciding on the action to be taken by the repair and salvage unit. He may decide to repair the aircraft on the spot, taking into consideration such factors as the nature of the ground and the practicability of flying the aircraft off after repair.

Often, however, this is impossible—the crash may have occurred on a mountaintop, in a forest, a field or a bog. Wherever it is a skilled party of fitters immediately set out for the scene. The trip may be simple enough during summer months, but often the work must be completed during downpours of rain, or in intense cold. Salvage and repair go on however, in spite of the weather and whatever the difficulties.

Seawater causes rapid corrosion of light alloys, so salvage of aircraft from the sea must be completed with the utmost speed. This holds good, in fact, of any underwater work. Although a crash party does not normally deal with aircraft which have sunk in deep water, the group recently staged a full-dress "naval occasion" on an inland lake in which a heavy bomber had sunk. Before salvage could be carried out, an experienced deep-sea diver was needed, while a local army unit supplied pontoons on which the salvage men rigged improvised lifting gear.

As a result of experience gained largely since the outbreak of war, special equipment has been evolved. The type of mobile crane employed, for example, is capable of operating under all conditions, being fitted when necessary with caterpillar tracks for use over soft ground. The most familiar vehicle, however, is the Long Low Loader, affectionately known as the "Queen Mary" because of their length. More than 60 feet in overall length, this vehicle is capable of carrying a complete fighter aircraft, or the sections of the largest bomber.

Similarly, a range of equipment, chiefly in the form of trestles, has been evolved for use in conjunction with the "Queen Mary." This enables a very large variety of aircraft to be carrried with the minimum of expenses and complication. Other items of special design, such as jacks for lifting crashed aircraft prior to dismantling and loading, have also been designed.

This special equipment cannot always be used. When a bomber crashed—wheels up—on a Welsh mountainside, 2,000 feet above sea level, salvage operations were begun in the face of what seemed to be impossible conditions. The nearest road was three miles away. The only approaches to the mountainside on which the plane lay were twisting paths made by mountain sheep. Yet the bomber was saved. Piece by piece it was gradually brought down the mountainside on improvised wooden sledges drawn by teams of horses, until at last the road was reached and the loading could be managed.

On another occasion a *Whitley* bomber crashed on a small island off the Scottish coast. Air reconnaissance showed that it appeared to be only slightly damaged and it was decided, therefore, that it must be salvaged and put into service again. It lay on a rocky headland to which there was no access other than an inlet from which the cliffs fell hundreds of feet sheer to the sea. A salvage party was landed on the island and dismantling began. When the component parts of the aircraft were ready for transport, a drifter from the mainland approached as close inshore as was possible. The components—including the engines, main planes, and sections of fuselage—were then lowered down the cliffs by improvised tackle to a lifeboat below. The lifeboat—all but submerged beneath the weight of some of the sections—was towed to the drifter, where the components were slung on board and safely stowed for the voyage to the mainland.

That *Whitley* bomber was completely saved in 18 days, by a crash party which—like all the many parties of the group—refused to acknowledge defeat by a signal to headquarters: "salvage abandoned."

With the air war mounting in fierceness, and the forces growing in numbers, salvage work will increase both in extent and in importance. The men of the group will be working night and day grumbling, grinning, hauling, heaving—but nobly playing their part.

END.

An RAF salvage crew carrying away the much punctured tail of a Dornier Do-18 bomber for inspection and salvage.

AIR TRANSPORT AUXILIARY SERVICE

by

Lisle I. Bowater

"Air Ferry" delivers the goods. Civil pilots fly day and night in the shuttling of RAF aircraft from factory to aerodrome.

AIR Transport Auxiliary is the official title of the Service popularly known as "Air Ferry" which today is responsible for the delivery of all planes within Great Britain used by the RAF except those flown across the Atlantic by the RAF Ferry Command.

In the expectation that war with Germany, if and when it came, would mean instant bombardment and probable dislocation of communications, a group of experienced pilots was formed in 1939, with the idea of building up a corps to act as a communication-squadron between the Government's Headquarters and elsewhere. This idea originated with Commodore d'Erlanger, and, as Officer Commanding, he has developed ATA into the immensely important service it has become.

The original group of about 20 men were all experienced flyers, but ineligible for the RAF. Their offer of service was promptly accepted by the authorities and the group received its name. The pilots were given a uniform similar to that of civil aviation personnel; and a scale of rank was devised. From cadets upwards in the scale, their ranks are: 1st, 2nd, and 3rd officers, flight-captain, captain, commander, senior commander and commodore.

At this time, the group was administered by the British Overseas Airways Corporation under the auspices of the Air Ministry. Soon after the outbreak of war, the awaited bombardment having failed to materialize, it became evident that these pilots could be of great use to the RAF in ferrying military aircraft. They were given a test and passed fit to fly Service aircraft on non-operational duty.

ERIC VANSITTART BOWATER, THE DIRECTOR GENERAL OF AIRCRAFT DISTRIBUTION, is one of England's leading industrialists. He served in the Royal Artillery in World War I, and now is responsible for the efficient operation of the Air Transport Auxiliary in the ferrying of new aircraft from the factories to RAF maintenance Units and Commands. He also is responsible for preparation, storage and dispersal of aircraft, mechanical transport, aerodrome and flying control, so far as the ATA is concerned. He reports directly to the Ministry of Aircraft Production. In civil life he is chairman of several paper pulp mills.

At first this was a comparatively easy job. But with the Battle and subsequent fall of France, when every aircraft and every man was so desperately needed, the ATA came into its own. The Air Ministry called on Commodore d'Erlanger to take over the whole of the ferrying of aircraft that had until then been done by RAF pilots. The original pilots were re-

Comm. Pauline Gower is head of ATA's women's activities.

Experienced women pilots of the Air Transport Auxiliary, who are known as the "Ata-girls," now number more than 100. They can fly any one of about 140 different types.

As radio cannot be used by ferry pilots, each delivery flight requires a thorough knowledge of all landmarks.

Careful record is kept of all ATA deliveries. Roll of civilian pilots includes Americans, Canadians, Poles.

inforced by hundreds of volunteers. As fast as planes could be built the ATA steered them into service.

When in August, 1940, the ATA was transferred from the Air Ministry to the Ministry of Aircraft Production, the urgent need for more ferry pilots to cope with the increasing output necessitated continuous recruitment. Broadcast appeals both here and in the United States brought a tremendous response.

Over 250 Americans have passed through the ATA's ranks. Their contracts having expired at the end of a year, many have now returned to their own homes, but there are still nearly 100 American citizens in the service.

Women pilots were admitted to the ATA early in 1940. At that time they numbered less than a score, now 100 are on the roll. Their inclusion is largely due to the efforts of Commander Pauline Gower, C.B.E., who is in command of the women's section of the service. The women work side by side with the men under exactly similar conditions. Although in early days they were permitted to fly only trainers and non-operational types, their efficiency was such that all restrictions have now been removed. Cadets of both sexes on entering the service are given a series of progressive conversion courses on the advanced types of aircraft. The duration of this training is entirely a matter of the pupil's adaptability. Only recruits with actual solo-flying experience are accepted.

The ATA has had many famous names on its roll, and probably more survivors of hair-raising adventure than any other group of individuals of its size. Space is too limited to record any exploits here, but the names of Amy Johnson and Jim Mollison, among an impressive list, are known across the world.

It takes an all-around pilot to be able to handle any of 140 different types of aircraft, from baby *Moth* to Boeing bomber. That is what these people must be able to do. And flying over war-time Britain is no "slice of cake"—to quote the RAF.

You may think there's not very much in a hop across an island of such puny size, but every mile of the ground below bristles with danger. Ack-ack guns and barrage balloons for instance. The A.A. batteries are apt to take no risks with unfamiliar and unlooked-for trespassers in the sky.

Moreover landmarks are scarce. We have nothing as wide as the Hudson in the way of rivers and railways are such a close network that a particular track is not easily identifiable. Mountains don't exist, and even hills almost disappear in southern England. Britain, in fact, is no paradise for the ferry pilot, struggling to find one of its hundreds of airfields in weather that only one adjective can adequately describe. This British weather is desperately serious for ferry pilots flying as they do, by charts without radio. The air must be kept clear for operating squadrons, and the ferry pilot must fly alone.

One pilot from the United States had an uncomfortable ex-

(*Continued on page* 260)

Commodore Gerard d'Erlanger (seated), originator of the Air Transport Auxiliary.

Ferry pilots continue study of maps as they are taxied to aircraft factories where newly completed planes await delivery. Taxi plane pilot is Sir Anthony Lindsay-Hogg.

CIVIL AVIATION

Though just a bare skeleton of its former self, civil aviation in Britain should be credited with having given much to the RAF.

by W. P. Hildred

WILLIAM P. HILDRED, O.B.E., M.A., has been director-general of civil aviation since September, 1941. He was appointed deputy director in 1938 and, in 1940, visited Canada and the United States as the principal assistant secretary of the Ministry of Aircraft Production. Throughout the last war, he served in the First Battalion of the Yorkshire and Lancashire Regiment. He joined the Treasury in 1919 and has been finance officer of the Empire Marketing Board, head of the Special Measures Branch, Ministry of Agriculture and general manager of the Export Credit Guarantee Department. He is a major in the Civil Service Battalion of the Home Guard.

WHEN Germany began to move against Poland in the summer of 1939, Britain immediately cleared the skies for her warplanes by sweeping away all civil aircraft west of a line running roughly from Southampton, through Birmingham to Perth in Scotland. This area was prescribed in an emergency Air Navigation Order, issued on August 31, 1939, which prohibited all flights except those permitted by the Secretary of State on grounds of national interest. The same order limited the heights and weather conditions under which flights would be permitted, specified the places and corridors of entry and exit for aircraft approaching or leaving this country, and restricted the use of wireless on civil aircraft.

When war was declared the aircraft of the various civil companies were immediately diverted to special transport tasks on which they rendered invaluable assistance. This was the first step in gearing British civil aviation to Britain's war machine.

From that moment British civil aircraft, and British civil flyers, have played an increasing part in the all-in war effort of the British Commonwealth. Like the ships of the merchant navy they have been used in a thousand fetch-and-carry jobs, handling mail, passengers and freight—a veritable mercantile marine of the air. By their speed and ability to overstride

First direct wartime flight from Britain to the U. S. was made by the Short "Clare."

vast distances across land and water they have formed a vital link in the chain of communications between Britain and the distant ports of the Empire, and to Allied and neutral countries.

To divert aircraft and personnel from the routes and services of peace to wartime needs, a series of further steps were taken.

On September 2, the day after Hitler struck at Danzig, the Empire Air Mail Services were restricted to two weekly runs from England to Sydney, Australia, and one to Durban, South Africa, India and Kisumu, in East Africa. On September 2, 1939, an order was made prohibiting the sale, transfer or hire of any aircraft, engine or propeller within the United Kingdom and a wide field of British territory, except by licence.

Sir Archibald Sinclair visits the "Clare" before the take-off for the United States.

By the second week of the war it was announced that British civil aviation had been established on a war footing, and was in action under the Air Ministry's Director-General of Civil Aviation. Wartime policy was defined as, first to enable civil airline operators to continue a number of essential services, and secondly to meet the urgent air communication and transport needs of the Government generally.

During the mobilisation period many thousands of miles had already been flown transporting key personnel, essential equipment and stores to war stations. Important personnel—and personalities—had been flown with speed and secrecy to places overseas; and both the transatlantic and Empire air services had been maintained, carrying passengers, freight and mail of importance to the war effort.

With the advent of war a considerable rationalisation of the operating companies, both internal and external, was effected. The two big companies operating from Britain internationally were Imperial Airways and British Airways. In 1938 the Government had decided that the undertakings of these two companies should be merged into one corporation. In August, 1939, the British Overseas Airways Act, 1939, received the Royal Assent and in November, 1939, the British Overseas Airways Corporation was brought into being. The corporation was required to place its services at the disposal of the Secretary of State for Air and they have since been operated in accordance with his instructions.

On the outbreak of war 17 internal air transport companies, which had operated regular and charter services in the British Isles or between this country and the continent, voluntarily turned over their fleets to the Department of Civil Aviation. Of these only six undertakings now maintain a separate existence: Allied Airways, Scottish Airways, Great Western and Southern Airlines, Isle of Man Air Services, West Coast Air Services, and Railway Air Services. The last five companies are associated in an organisation known as the Associated Airways Joint Committee. Services are operated only over those routes which are adjudged to be essential for the war effort. Services are operated between the mainland and the Scilly Isles, Eire, Northern Ireland, the Isle of Man, the Hebrides, the Orkneys and the Shetlands.

The remaining civil companies are occupied on repair and maintenance work for the RAF, or on other important war work.

After six months of wartime experience a further step in the control and allocation of civil aviation became neces-

The giant four-engined Armstrong-Whitworth "Ensign," Imperial Airways' luxury airliner, capable of seating 40 passengers, was brought into service shortly before the war. It formerly flew British Empire routes.

sary. A number of civil type aircraft which were in use on RAF communications, as searchlight targets, for training crews, for other Army co-operation work, for training spotters, and for observing the blackout and camouflage were turned over to the direct control of the RAF.

At the same time other jobs had been growing up, notably the Air Transport Auxiliary (A.T.A.), certain repair and maintenance work for the Ministry of Aircraft Production; and the transatlantic *Liberator* services run in conjunction with RAF Ferry Command. Their work is dealt with in other articles in this issue.

War conditions have increased the perils and inherent difficulties of flying, apart from any risk of damage by enemy action. Restrictions on radio transmission and the reduction in meteorological broadcasts from neutral territories have whittled down navigational aids. Pilots on transocean passage fill in the gaps as best they can.

Many old and recognised routes and stopping places, too, have gone as the tide of battle has flowed over previously friendly territories. Deviations from direct routes with good ground organisations have been necessary; longer or more difficult hops have to be made over routes where the services are often improvised.

Another factor working against British civil aviation at war is the ageing of its equipment, and the steadily increasing difficulty of maintaining it. That old ships, which but for the war would have been replaced, are still kept airworthy is a tribute to the skill and contrivance of their civil operators.

Despite those difficulties Britain's civil air fleets keep the air. Here are the hard figures for aircraft of the British Overseas Airways Corporation operating in and out of Great Britain: total mileage for the year ended June, 1941, 5,615,865 miles; passengers, 22,031; mails and freight, 1,315 tons.

Shortly before the war a number of new types of British aircraft had been introduced into service on the various routes. Two de Havilland D.H.91's had been built for mail flights across the Atlantic, and a modified version, the *Frobisher* was employed on European services. The Armstrong-Whitworth A.W.27 *(Ensign)*, a four-engined landplane seating 40 passengers, was in use on the London-Paris service. The de Havilland D.H.95 *(Flamingo)*, a twin-engined, high-wing landplane, had been employed between this country and the Channel Islands.

There was, however, only a limited number of these types and unlike Germany, Britain had no great pool of large civil aircraft to call on, either for replacements on vital services or for use as troop transports. For this reason, and because production had to be concentrated on military aircraft only, Britain was forced to seek additional transport aircraft elsewhere, mainly in the U. S., if her air communications to the battle fronts overseas were to be maintained.

It need be no secret that registrations of British civil aircraft are now down to less than half the pre-war figure. Britain's civil aviation is concerned with the only objective that matters, winning the war.

Military equipment of the RAF has, in the past, gained a great deal from its civil counterparts, not only in the matter of design, but also in the direct use of civil types on wartime duties.

Another airliner now doing transport and ambulance work is the DeHavilland "Flamingo," shown over the Isle of Jersey.

The DeHavilland "Dragon Rapide," extensively used before the war in the operation of British internal airlines. At the outbreak of war 17 British internal air transport companies were operating.

D. H. 95 *Flamingo*, and D. H. 89 *Rapide*—renamed *Dominie* by the RAF—have done good work on transport and training work. So has a light four-seat cabin monoplane, the Percival *Vega-Gull*, renamed *Proctor*, a useful machine for communications work.

Several types of British service aircraft have been derived from civil types. The famous Bristol *Blenheim*—bomber, fighter-bomber and long-range fighter—was derived from the Bristol 142 airliner built for the personal use of Lord Rothermere some eight years ago. It was presented by him to the British Government after it had proved itself to be one of the fastest passenger transports in the world. The wings and tail unit of the *Whitley* bomber, which was one of the RAF heavy night bombers during the first two years of the war, were constructed on much the same lines as those of the Armstrong-Whitworth *Ensign* built for Imperial Airways. The *Hertfordshire* troop carrier was derived from the D. H. *Flamingo*. The *Anson*, Coastal Command's gallant little reconnaissance ship and a ubiquitous training type, was derived from the old Avro 652. A standard RAF two-engined trainer, the *Oxford*, is a development of the Airspeed *Envoy*, a freight and passenger carrier; and the world famous *Sunderland* is direct cousin of the Short flying boats of the *Empire* class.

One other thing needs to be done in any article about Britain's civil aviation and its part in the nation's war effort. It is to pay a tribute to the pilots and the men behind the pilots and the aircraft—the maintenance crews, traffic control officers and meteorological personnel. Many of them have donned the blue uniform of the RAF and are to be seen on nearly all of the world's fighting fronts. The others carry on, under all sorts of difficulties, in all kinds of places, to keep Britain's civil aircraft flying, and the skies of freedom open.

END

Winston Churchill at the controls of the Boeing "Berwick," en route to England after a recent conference with President Roosevelt. The "Berwick" is one of Pan American's clippers purchased by the British for transatlantic operations.

HISTORY OF THE RAF

A history of the RAF might well be the story of modern aerial warfare. Britain's air arm is 30 years old.

This frail craft, a B.E.2b of No. 2 Squadron, was the first R.F.C. machine to land in France. The date: August 13, 1914.

MILITARY aviation as we see it today is only 30 years old. In 1908 A. Verdon Roe made the first aeroplane flight in England, and in 1911 an Air Battalion was formed; but it was not until April 13th, 1912 that the issue of a Royal Warrant formally constituted the Royal Flying Corps with two wings, one Naval, the other Miltary.

In August 1914 the R.F.C. had 179 aircraft, and the Royal Naval Air Service (as the Naval Wing was then called) had 39 aeroplanes, 52 seaplanes and seven airships. Though the Germans were far ahead of us in airship design, their air force took the field in 1914 with about 100 aircraft only (including those used for home defense) and a total personnel at the front of about 550. Their first seaplane unit on active service, consisting of two 120 h.p. Friedrichshafen machines, was not formed till December, 1914.

The R.F.C. figures, though impressive, were misleading. Less than 100 planes were fit for service and the personnel numbered little over 2,000. Nevertheless they were quickly in action. As early as August 13 Squadrons Nos. 2, 3, 4 and 5, flying a miscellany of Farman biplanes, Avros and Bleriot monoplanes landed in France, and on the 27th an R.N.A.S. squadron crossed to Belgium. On August 22nd an air reconnaissance discovered Von Kluck's Second Corps near Grammont, north of Mons—information which necessitated an immediate British retreat to avoid outflanking. Thanks to the R.F.C. the news came in time and encirclement was avoided In the same week, hand grenades and petrol bombs were dropped by hand. War in the air had begun.

By the middle of October aircraft were spotting for artillery, and soon gunner officers were making flights to plot enemy batteries. In November it became clear that the fronts were established and the main outlines of air warfare could be discerned. Three things were in demand: wireless sets, since this signalling method was independent of the weather; cameras, to photograph enemy positions; and machine guns—for air combat and ground straffing.

Throughout the early battles of the war—the Marne, the Aisne and the first battle of Ypres—the main duties of the R.F.C. were observation, liaison work and artillery direction—the latter by means of Very signals more often than by wireless telegraphy. The R.N.A.S., keeping watch for enemy submarines or minelayers and carrying out preventive attacks on German airship sheds from bases at Dunkirk and Antwerp, provided, too, for the home defence of Britain.

The conception of an air offensive in which there should be co-ordination of air and ground operations came in 1915. At Nueve Chapelle British troops went into attack with a composite picture of the enemy's hidden defences to guide them. In this operation and in the second battle of Ypres, the R.F.C. were recognized by the commander in chief to be indispensable. Thus when, after a year of war, Colonel Trenchard took over air command from Sir David Henderson, it was agreed that the expansion of the R.F.C. should keep pace with that of the expeditionary force, which had already increased from four to 30 divisions. Following a period of

One of aviation's early flights from a ship at sea was that made by this Sopwith 1½-Strutter from a platform on a cruiser.

Great-grandfather of the modern RAF torpedo plane was this Short seaplane of 25 years ago. Landplanes do this work today.

A DeHavilland D.H.2, an early single-seat fighter, flying Flight Commander's streamers, takes off at Beauval in 1916.

scepticism, generals were becoming air-minded. When Colonel Brancker put forward plans for 50 squadrons, Lord Kitchener made only one addition to the minute: "Double it."

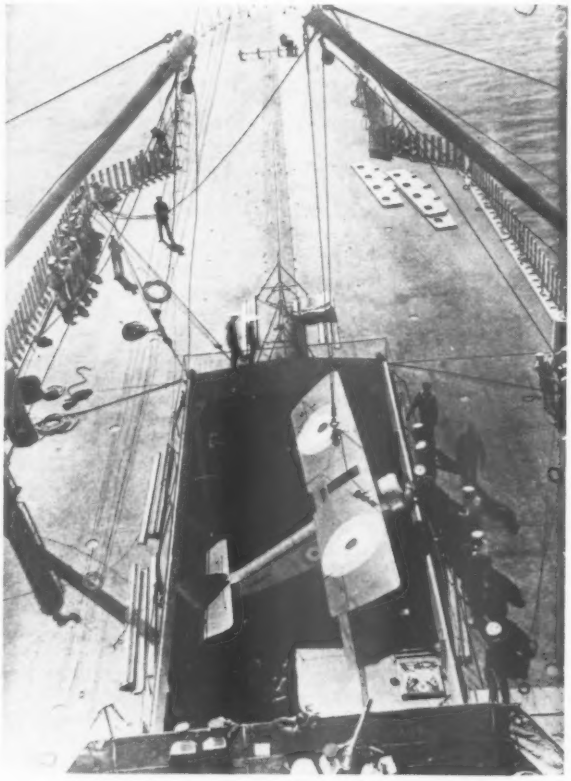
The Battle of Loos in September and October of 1915 showed what air mastery could accomplish. Determined air attacks on their railway traffic—attacks made more deadly by an improved bomb-sight—impeded German troop movements. But late in October came the counter-stroke—the Fokker single seater monoplanes, strong numerically and equipped with machine guns synchronised to fire through the propeller. For a time the Fokker, a "flying gun" which aimed directly at the target ahead, was predominant. The British Vickers "gun-bus" could usually hold its own in single combat, but reconnaissance aircraft were almost helpless and orders were issued that they should fly in formation of not less than four.

Meanwhile the R.N.A.S. were rendering distinguished service at Gallipoli where they enjoyed undisputed technical superiority. Versatility was their virtue. "Drachen" balloons from the base ship *Manica* spotted with outstanding effect against both Turkish land forces and battleships. Seaplanes directed monitor fire on forts and troop concentrations, and brought off the first aerial torpedo hit on a supply vessel. A continuous watch was maintained from the air over submarine routes and minefields, while land patrols kept off enemy aircraft. Turkish camps, communications and trenches were constantly subjected to attack, air reconnaissance enabling British troops to anticipate countermeasures. Though the campaign did not succeed in its object, British aircraft did their work well.

Nor were tasks nearer home neglected. Submarine bases in Flanders were bombed and the submarine scout airship or "blimp" was put into service. A daring raid on the Zeppelin sheds at Friedrichshafen (Lake Constance) by three British planes based at Belfort had been made in November, 1914. Then once again the threat of the Zeppelin to British home security was temporarily checked by the destruction of two out of three of the newest type of raiders, one being bombed in its shed at Evere, and the other destroyed in the air over Ghent by bombs dropped from a Morane monoplane.

By 1916, De Havilland scouts and formation flying were overcoming the initial advantage of the Fokker fighter, and British synchronised fire control gears, though slow in development, eventually surpassed the German types. The R.F.C. had confirmed its instinctive belief that aggression was the best means of air defence. For army co-operation a new method of "contact patrol" was devised. This enabled observers to report accurately on enemy positions, to advise headquarters of their own troops' progress, and to transmit messages from the front lines to their divisional H.Q.

The first successful attempt to fly off a Sopwith "Camel" from a lighter towed by a destroyer was made July 31, 1918.



One of Britain's first aircraft carriers was H.M.S. Furious. Here is a Sopwith "Pup" fighter coming up from its hangar.

The R.F.C. were thus prepared to afford maximum support to the infantry in the battle of the Somme. Employing co-operative control and determined to fight the air war over the enemy's lines, they made a notable contribution to the early British successes. By a massed bombing offensive on railways, aerodromes, distribution points, and billeting centres, they gave the German troops a feeling of defencelessness. Throughout the entire course of the war the morale of the infantry on either side was greatly affected by any failure of air power.

It was not until the German High Command concentrated new pursuit squadrons of the Albatros type, that the R.F.C. felt their mastery threatened. By that time the morale of the German armies had suffered a devastating blow, for they had been forced to abandon the onslaught on Verdun. The new German planes were too late to exercise maximum effect, but they achieved considerable successes.

In the period September to November home defence air-

Bristol Fighters, operating on the Italian front in 1918, are shown crossing the Alps in formation.

craft, now placed under War Office control, accounted for seven Zeppelin raiders. Night flying training was also inaugurated at Hounslow to provide for greater security against bombing raids. Relieved of defence responsibilities in Britain, the R.N.A.S. intensified its offensive against aerodromes and Zeppelin bases in Belgium, besides taking part in attacks on munition centres in Germany.

Fighting squadrons of the R.N.A.S. reinforced the R.F.C. during the battle of Arras and in the Flanders offensive of 1917. Heavy air fighting and fierce struggles for local supremacy were part of the artillery preparation for Allied attacks. The enemy retired, but to prepared positions behind the Hindenburg Line. This retirement was harassed by the first systematic low-flying attacks—a technique which when first tried out at Arras and the battle of Messines, caused confusion among enemy transport columns, and remained afterwards an important aspect of air co-operation. For the second time, however, the enemy produced fighting aircraft of a superior quality. "Circus" formations appeared—the first under the famous Richthofen—and the German Air Service reached the peak of its power. Throughout the third battle of Ypres and at Cambrai air engagements were so continuous and severe that up to 30 per cent casualties were suffered by the R.F.C. personnel. The losses inflicted on their opponents may be judged from the fact that in August alone 135 enemy aircraft were destroyed and another 103 forced down; 1,860 hostile batteries were brought under artillery fire through air co-operation; while 304 gun pits were destroyed and 803 damaged.

The gratitude of the troops may be judged from this notice which appeared in "The Times" In Memoriam column:

To an Unknown Airman shot down 23rd November, 1917, attacking a German strong-point southwest of Bourlon Wood, in the effort to help out a company of the Royal Irish Rifles, when other help had failed.

In January, 1918, General Trenchard returned to England to become Chief of Staff to the newly created Air Ministry, and it was under Maj. Gen. J. M. Salmond that the British crews and aircraft were put to the severest test of the war. In March, 1918, the Germans began their drive towards Amiens. The R.F.C. were called on to stem this advance. Low-flying and bombing attacks continued regardless of risk, mechanics keeping every available machine in the air. Two and a half million rounds of ammunition were fired on enemy troops. The westward thrust was held. In one week as many as 220 German aircraft were forced down by British airmen flying Sopwith and Bristol fighters. The R.F.C. had again established air superiority over their adversary.

That this superiority continued was in no small degree the result of training and technical progress made about the same time. The original Central Flying School at Upavon had been supplemented by centres for recruit training at Halton, for wireless operators at Farnborough, observers at Brooklands, riggers at Reading and for aerial gunnery at Hythe. But no striking advance was made in flying training until the introduction of the Gosport system late in 1917. Every possible maneuver was taught in this school of special flying. When Gosport pupils reached the Western Front, maneuvers till then considered desperate risks, were practiced as routine tactics to bewilder and defeat the enemy.

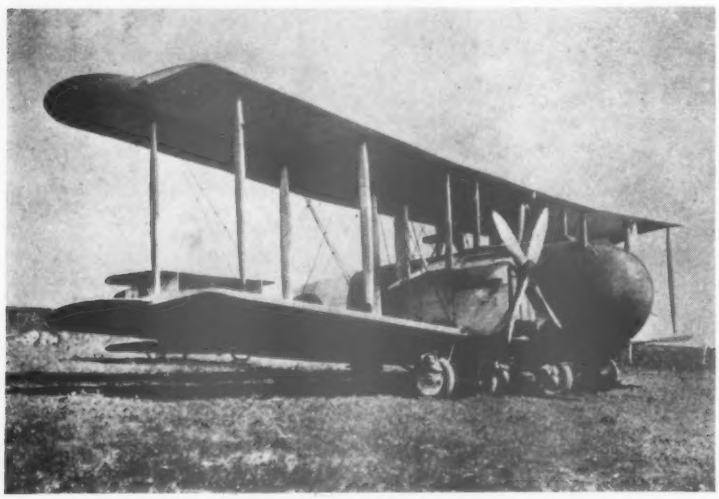
The R.N.A.S. were not out-distanced in the race for technical improvement. As a result of long research, aeroplanes

This is one of a fleet of Handley Page bombers that was assembled by the RAF for attacks on Berlin, when the war ended.

were successfully launched from the platforms of light cruisers or from the turrets of battle cruisers, thus gradually replacing seaplanes for ships' use. Boat seaplanes of a new type, operating from Felixstowe in a sectional patrol known as the "Spider's Web," played an important part in reducing the serious losses caused by submarine attacks on merchant shipping. These flying boats accounted for two submarines in the last week of July, having previously destroyed two Zeppelins engaged on reconnaissance. Aeroplanes taking off from cruisers in the North Sea then went into the attack and a third Zeppelin fell in flames.

Special aircraft carriers were now designed, of which the *Argus* was the first. Other developments included the towing of kite-balloons by submarine and the construction of small airships for fleet reconnaissance and anti-submarine patrol. Seaplanes and aeroplanes could then be put to the more exacting task of bombing enemy bases at Bruges, Ostend and Zeebrugge, or of intercepting German Gothas which now replaced the Zeppelins in raids over London and southeastern England.

The daylight attacks on London, and the competition for supplies of aircraft, more than anything else, were the basic reasons for creating an Air Ministry and amalgamating the two air services. Competition between the R.F.C. and R.N.A.S. for aeronautical supplies, and differences of policy in their use, had caused pronounced public disquiet. When on July 7, 1917, 22 German aeroplanes raided London in broad daylight killing 103 people and wounding 316, and, despite 95 pursuing planes and the fire of 57 gun stations, got clear with only one loss—this through engine trouble—there was a strong demand for revised organisation and combined defence measures. Public clamour resulted in the retention for home defence of 400 planes. Probably the total enemy forces available for raiding hardly ever exceeded a tenth of this figure.



Part of the RAF's resources for policing Iraq in the early 1920's, this Vickers "Vernon" troop carrier held about 20 soldiers. Present carrier is Bristol "Bombay."

Later in the year came the Air Force (Constitution) Act and on April 1, 1918 the Royal Air Force came into being. The decision to break with traditional policy, both in Great Britain and elsewhere, of having only two military services, a Navy and an Army, was not lightly undertaken by the War Cabinet, headed by Lloyd George. It came only after a full and impartial enquiry by a special committee presided over by General Smuts, a member of the War Cabinet, and after various other methods of overcoming the difficulties which had arisen had been thoroughly tried and tested. In retrospect, this decision to create a separate Air Ministry, a unified Air Force, and an independent Air Staff is seen to have been a change of great historic world importance.

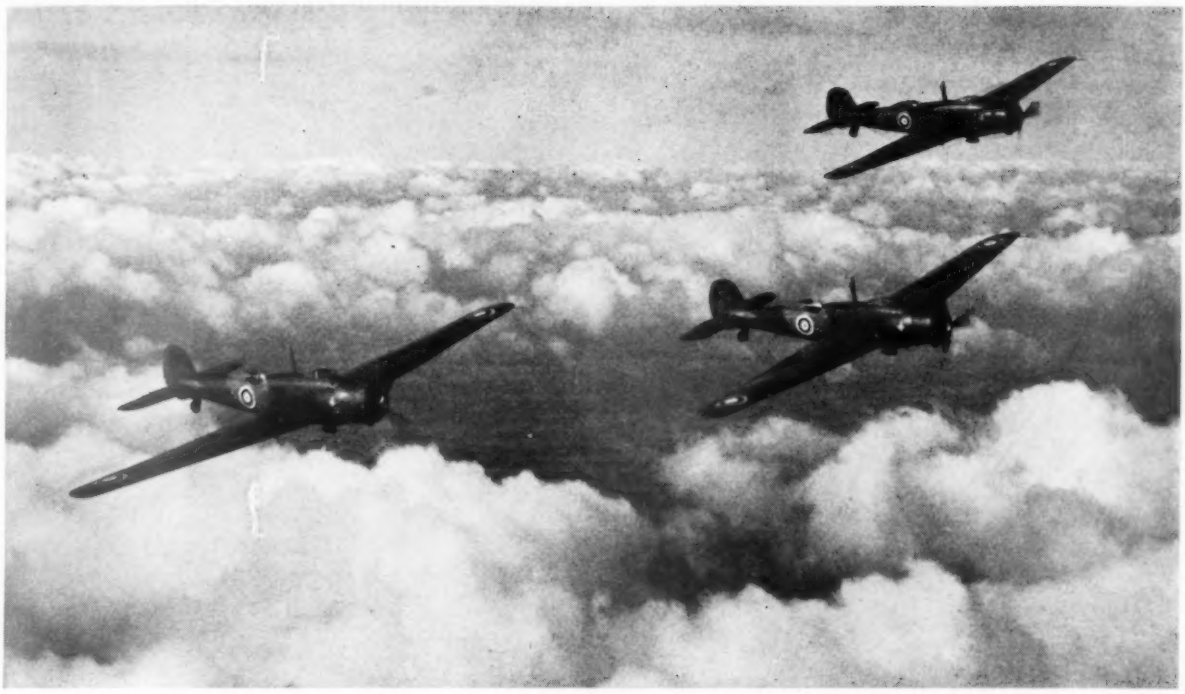
The German spring offensive of 1918 had provided the RAF with perfect ground targets: troops in movement. Bristol and *Camel* squadrons had held the attacks of "circus" formations, while low-flying assaults were made on the advancing enemy. Now came the Allied counter offensive. The RAF concentrated 1,390 aircraft on the Amiens front against a German force of 340. Air co-operation with infantry and tank advances nullified the effect of anti-tank guns, while bombing attacks impeded the assembly and supply of German reinforcements. Sweeps by as many as 65 aircraft in formation cleared the sky of enemy forces and intensive bombing of hangars destroyed many machines. German countermeasures were thus paralysed. When the Allied advance became so rapid that reserves of food for the forward troops were exhausted, RAF squadrons transported rations to the front lines and the advance went forward.

Now everywhere came signs that the Central Powers were cracking. The campaign in which the effects of air predominance show most clearly was conducted in Palestine. By grounding the enemy air force and thus preventing reconnaissance, General Allenby sprang a surprise attack over ground made familiar from aerial photographs. Smoke-screens dropped by contact patrols enabled attacking infantry to reach the enemy lines. Communications were disrupted by bombing and possible routes of escape were constantly watched. The Turks broke. Their retreat led through narrow defiles and here all available aircraft were immediately concentrated. To quote Lawrence: "at a cost of four Air Force casualties we destroyed an Army Corps." Sustained bombing and machine-gun fire turned retreat to rout, and rout to chaos. By the end of September, of the seventh and eighth Turkish armies, no organized body remained.

While the periptieral forces were cracking, air blows were struck at the heart of the enemy. A result of the Gotha raids on London was the decision of the General Staff determined to bomb industrial areas in Germany. The VIIIth RAF Brigade carried out 57 raids on Cologne, Stuttgart, Mannheim, Mainz and Coblenz, and so successful were these attacks that it was decided to constitute a separate long-range bombing force whose specific task would be bombing. During the five months of its existence the Independent Force, created in June, 1918, under General Trenchard's command, extended the bombing offensive to Gotha aerodromes, railways and Rhineland chemical works. Though it inflicted much damage on German war industry, its most powerful effect was moral. Recurrent bombing by day and night undermined the German nation's capacity for resistance. Plans were prepared to bomb Berlin, and a fleet of Handley Page long distance bombers were in readiness three days before the Armistice.

The RAF had mastered the Zeppelins. Of the Gothas, six out of 38 were destroyed, in their final attempt on the capital. Fokker and Albatros had been overcome and Circus had been decisively beaten. But though German resistance at home and in the field was weakening, their sea attacks continued. To attack the menace at its roots combined naval and air sorties were made on Ostend and Zeebrugge in April and May, 1918. Both bases were decisively damaged, and 12 submarines and 23 torpedo boats were trapped in the Bruges canal. Meanwhile, for home waters, a new anti-submarine organisation had been formed in which kite balloons, seaplanes, aeroplanes and airships all played a part. In the course of the year these forces sank or damaged 31 submarines. A further scheme was evolved to check U-boat movements at sea. Lighters towed by destroyers were employed as flying-boat platforms, and by this means reconnaissance was carried out over Heligoland Bight, where enemy minesweepers were clearing lanes for outgoing U-boats. The aircraft carrier *Furious* took part in these operations and her pilots had the satisfaction of destroying two Zeppelins in their sheds at Tondern. But the German naval air service still showed high morale and running fights between British flying boats and German seaplanes continued to take place as near home as the Thames estuary.

Once in the lead on the field the RAF gave the German forces no respite. In the Battle of Bapaume they proved as brilliant a vanguard in the advance as they had formed a



Two of these Vickers "Wellesleys," in November, 1938, flew non-stop from Ismailia, Egypt, to Port Darwin, Australia, establishing a new record of 7,162 miles. The third plane made one stop en route.

rearguard when the British were forced to retreat. As the Germans were drawn back, air units from Dunkirk helped to disorganise their communications, paralysing their reserve troops by intensive machine-gun assault and clearing enemy bases from the Belgian coast.

By this time American squadrons were in France operating under the RAF command. Though few in number, they distinguished themselves by daring and tenacity. On August 13, 1918, the 17th U. S. Aero Squadron took a part in the celebrated low-flying raid on the aerodrome at Varssenaire near Ostend. Three flights of Fokkers were bombed on the ground and the whole target was devastated. British and American pilots flying *Camels* dived low through the smoke to machine gun their various objectives. Though the force employed numbered over 60, they returned to their bases without loss.

The German Air Service fought hard, but organised bombing of railways, destruction of batteries, concentrated fire on strong points, and perfect cooperation with infantry movements carried the day. The Hindenburg Line was soon in Allied hands and by November 11 Mons was taken. The war was won and in the words of Sir Douglas Haig's despatch in "The advance to victory":

"The ever-increasing size of the RAF and the constant improvement in the power and performance of machines, combined with the unfailing keenness of pilots and observers" had played a large part. The conditions of the Armistice was designed to prevent any resumption of the struggle. Germany handed over to the Allies 2,000 aeroplanes.

Flying a special aircraft, Flt. Lieut. M. J. Adam flew to 53,937 feet in 1937.

In November, 1918, the RAF had over 200 squadrons—22,647 aircraft of all types including 3,300 on first-line strength, together with 103 airships. Personnel totalled 291,000 officers and men. Operations had taken this force to Italy (where they shot down 400 enemy planes) to Egypt, Mesopotamia, Sudan, West Africa, India and the Near East. Not only in numbers, but in range, speed and rate of climb the RAF led the world. Service aircraft had reached a ceiling of 24,000 feet and speeds exceeding 140 m.p.h.; the North Sea type airship was capable of flights of a hundred hours' duration.

Flying had made great strides but it was still an instrument of war rather than of peace. Civil aviation could not absorb the disbanded pilots. But a fortunate few were able to recapture the pioneering spirit of the years before the war. In June, 1919, Capt. John Alcock and Lieutenant Whitten Brown flew a Vickers *Vimy* aeroplane from St. Johns, Newfoundland, to Clifden, Ireland, in just over 16 hours. Next month the airship R-34 crossed from East Fortune, Scotland, to Long Island and back, sending wireless reports regularly to the Air Ministry in London throughout a cruise of 6,000 miles. In November Capt. Ross Smith, Lieutenant Keith Smith and two Australian crew piloted a *Vimy* by five stages from Hounslow to Port Darwin, Australia. Setting out from Brooklands the following February, Wing Com. P. Van Rynefeld and Flight Lieut. Q. Brand, after crashing their original Vickers machine en route, reached Cape Town by March in a De Havilland. In 1921 RAF planes operated an official air mail service between Cairo and Bagdad, crossing Iraq. They were guided on their course by tracks ploughed over the Syrian desert.

The Cairo-Bagdad route was part of a considered plan. Mr. Churchill, as Secretary of State for Air, had in 1919 put forward a scheme from the Chief of Air Staff for the permanent organisation of the RAF. The bulk of service units were to be stationed overseas in Egypt, Mesopotamia and India. Egypt, by its situation and climate, formed the natural headquarters of the Air Force in the Near and Middle East. With detachments of seaplanes at Malta and Alexandria to support the squadrons in Cairo, the RAF could watch over a main highway of world commerce.

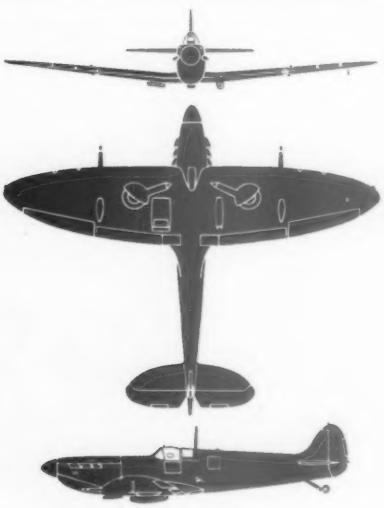
Attention having been turned to air communications within the Empire, long distance service flights were undertaken for

(*Continued on page* 186)

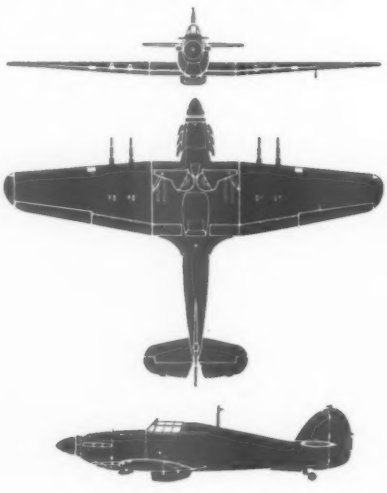
FOR IDENTIFICATION

Aircraft identification by silhouette is a fine science in Britain.
On these pages are 20 silhouettes of RAF types most commonly seen.

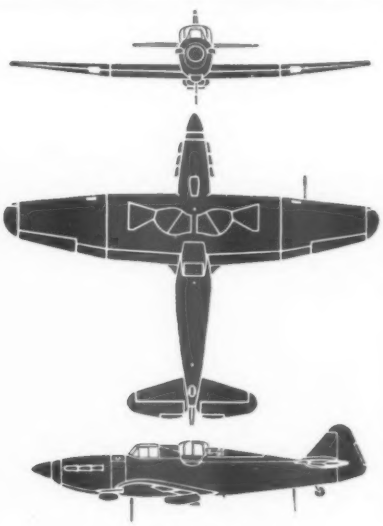
FIGHTERS



Supermarine "Spitfire V."

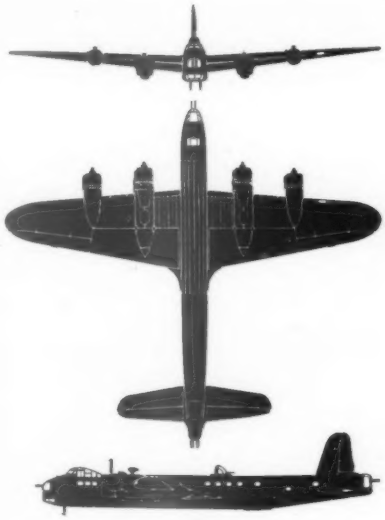


Hawker "Hurricane."

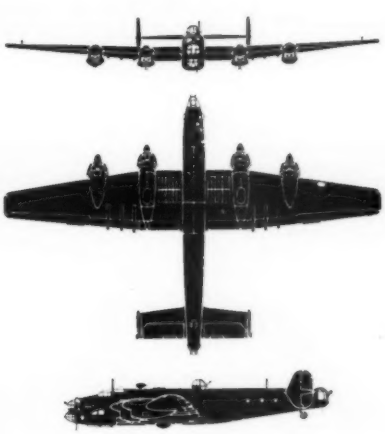


Boulton Paul "Defiant."

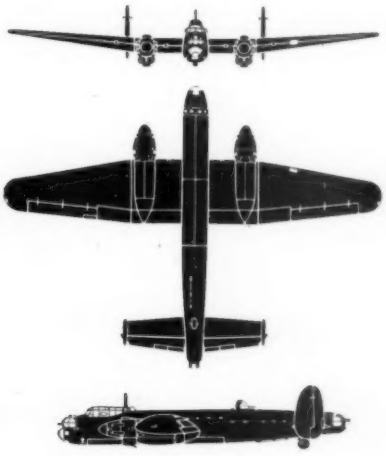
BOMBERS



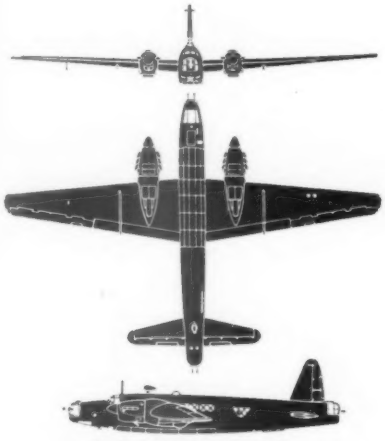
Short "Stirling."



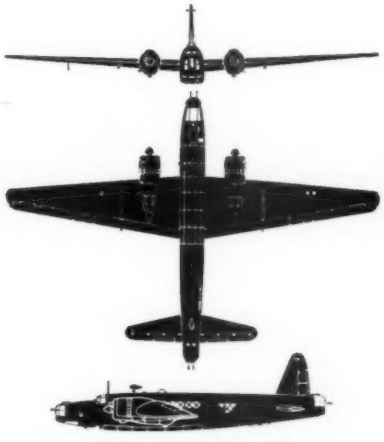
Handley Page "Halifax."



Avro "Manchester."

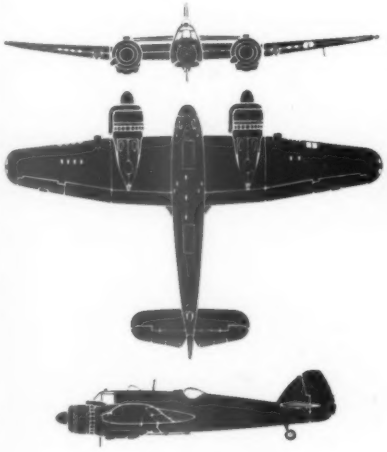


Vickers "Wellington II."

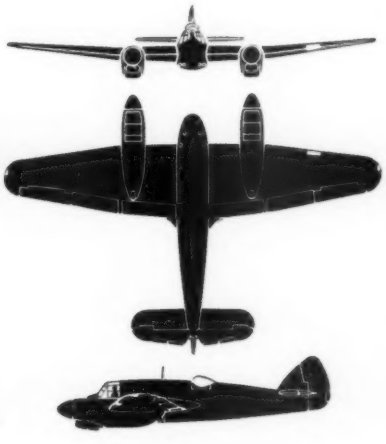


Vickers "Wellington IC."

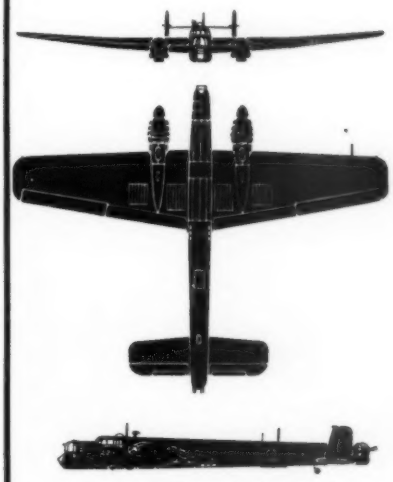
Bristol "Blenheim IVF."



Bristol "Beaufighter I."

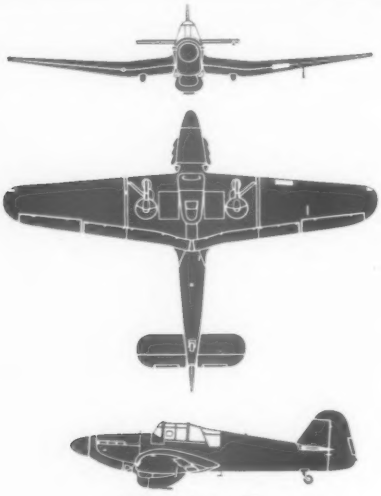


Bristol "Beaufighter II."

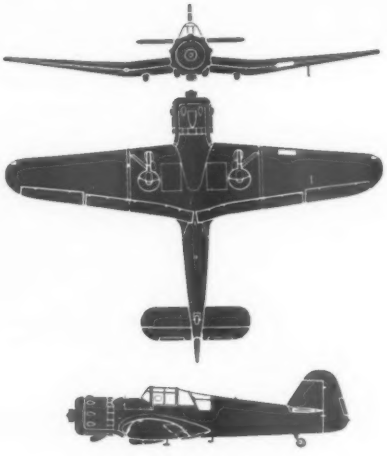


Armstrong-Whitworth "Whitley."

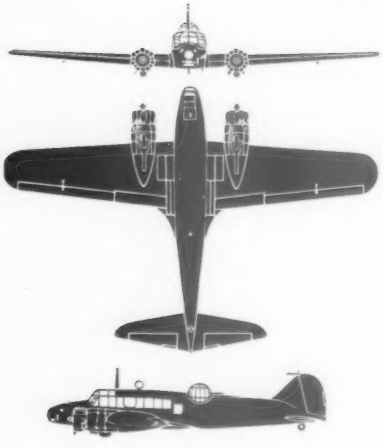
TRAINERS



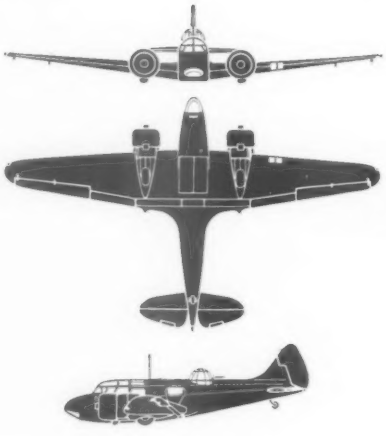
Miles "Master I."



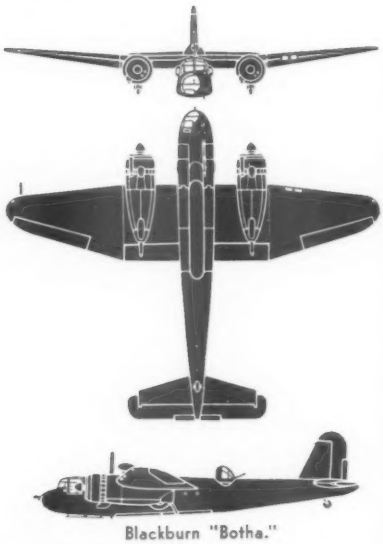
Miles "Master II."



Avro "Anson."

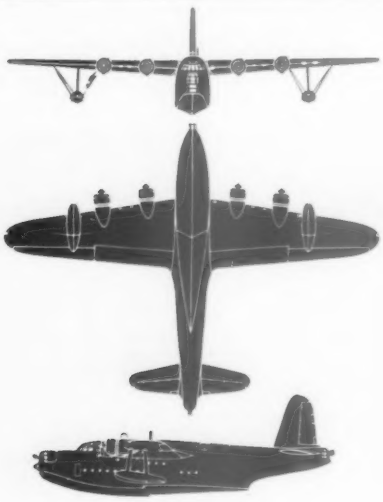


Airspeed "Oxford."

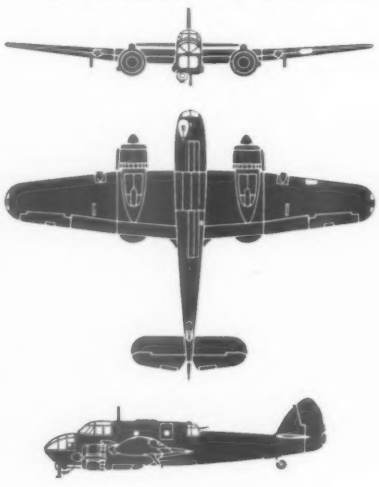


Blackburn "Botha."

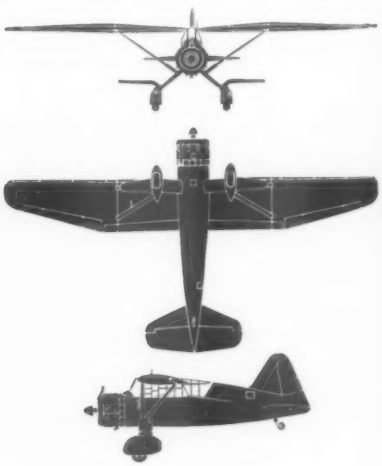
OTHER TYPES



Short "Sunderland."



Bristol "Beaufort."



Westland "Lysander."

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PIPER

POINTS THE WAY TO WINGS FOR ALL AMERICA

History of the RAF

(*Continued from page* 181)

the sake of experience and to test the reliability of British aircraft. Air Vice-Marshal Sir Sefton Brancker had flown with Alan Cobham from London to Rangoon and back in 1924; in 1927 a flight of four Supermarine flying boats, under Group Captain Cave-Brown-Cave's command, completed a cruise of 23,000 miles to Singapore. From there they made a circuit of Australia and survey flights to Hong Kong in preparation for regular air services. In the same year Flight Lieut. C. R. Carr and Flight Lieut. L. E. M. Gillman flew 3,419 miles from Cranwell to the Persian Gulf in less than 35 hours flying time; and from the same station in 1929 Squadron Leader A. G. Jones-Williams and Flight Lieut. N. H. Jenkins made a record non-stop flight to Karachi.

The pursuit of records was deliberate. No better means of keeping a peace-time air force on its toes could be found. There was in addition the series of Hendon Air Pageants which provided a useful stimulus not only to young pilots but also the public imagination. It was not, however, till Britain won the Schneider Trophy that the tremendous advance in flying speed which ten years of experiment had achieved was brought home to the man in the street. The speed of 281 m.p.h. which Flight Lieut. S. N. Webster reached in winning the coveted award appeared prodigious. And when Flying Officer D. Waghorn reached 328 m.p.h. in the contest and Squadron Leader A. H. Orlebar broke the world's record at 357.5 m.p.h., it was plain that the Supermarine Rolls Royce seaplane S.6 was capable of terrific performance. Two years later, in 1931, Flight Lieut. J. N. Boothman completed the course of 217 miles at 340 m.p.h., thus securing the trophy permanently for his country, but Flight Lieut. G. H. Stainforth reached 407 m.p.h. not long afterwards in a world record attempt and competent designers were prepared to prophesy that this figure would not long hold first place.

Records were won on the drawing board, but the designers were always in close touch with the men who flew. The relations between pilots, Air Ministry, and aircraft construction firms were astonishly frank and cordial. It was as though all concerned knew that a day might come when much might depend on the closeness of this relationship.

For the time being, however, there seemed little prospect of war, and the occasional operations overseas in which the RAF figured, appeared little more than routine police work to a public unaware of the distances and dangers involved.

In 1920 air operations conducted in Somaliland were the main factor in the overthrow of the "Mad Mullah," who had defied authority since 1900.

On the Northwest Frontier, aircraft were also proving their worth. The RAF checked the outrages of the Mahsud tribes in Waziristan by bombing their evacuated villages. For the loss of two men a campaign, which in 1919 had proved inconclusive after costing 1,329 casualties among ground forces, was successfully concluded in two months.

Air action was prompt, economical and humane. When a tribe in Afghanistan took up arms against King Amanullah, cut the road in the Khyber Pass and isolated the British Legation in Kabul, RAF squadrons from Egypt and Baghdad saved the situation. Crossing mountainous country in severe weather, they evacuated 600 civilians from Kabul, flying 57,000 miles for the loss of only two aircraft. In the same year, 1928, Aden Protectorate, 42,000 square miles of territory bordering the Red Sea and the Indian Ocean, was placed under control of the Royal Air Force. This had been a most difficult military command in which law and order was constantly set at naught within a few miles of the capital —Aden. Soon the solitary RAF squadron had the situation completely in hand at a cost of £8,000 compared with an Army estimate of about £10,000,000.

On January 1, 1920, the Air Ministry took over the entire research, design, construction and supply of aircraft from the Ministry of Munitions. As a final measure of unification, civil aviation and the airship service were also placed under the control of the Air Council.

In 1923 the Prime Minister, Mr. Baldwin, stated that our needs in regard to air defence should be:

"In addition to meeting the essential air power requirements of the Navy, Army, Indian and Overseas commitments, British air power must include a home defence air force of sufficient strength adequately to protect us against air attack by the strongest air force within striking distance of this country."

By 1934 it was clear that Britain's frontier lay on the Rhine. Germany was building up an air force and the British government "determined in no conditions to accept any position of inferiority with regard to what air force may be raised in Germany in the future." The program of squadrons for home defence was raised to 75 to be completed in five years, so that by 1939 the total British first-line air strength at home and abroad was to be 1,304 aircraft. Estimates based on good authority were already crediting Germany with 1,000 military aircraft, and in 1935 Hitler declared that Germany's air strength was equal to that of Britain. More serious than this was the fact that her power to expand this strength rapidly was incomparably greater than ours. There were then 580 aircraft available for home defence, but plans were set in motion whereby in March, 1937, the strength of the RAF based at home would reach 1,500 first-line aircraft.

This time the scheme was undertaken in earnest. Thirty-two new aerodrome sites were chosen and preparations were made to recruit an additional 2,550 pilots. One of the methods to overcome difficulties of expansion in production was the institution by Viscount Swinton of the so-called "shadow" factory scheme. These "shadow" factories were, in fact, huge state-owned workshops managed by the captains of the motor industry on a management fee basis: five firms in the automobile industry built the component parts of selected aero-engines, two factories turned out air-frames and others made propellers, carburetors and bombs. Separate works then assembled the whole output into complete aircraft or engines. In the course of time this subdivision of contracts became vastly more widespread, so that no temporary stoppage could halt the provision of equipment needed by the Royal Air Force whose first-line program had now risen to 1,750 aircraft for home defence.

A reorganization of the RAF at home was felt to be necessary to control and operate the greatly increased number of RAF squadrons. In July, 1936, four commands were created, all responsible directly to the Chief of Air Staff and Secretary of State at the Air Ministry. The Command entitled "Air Defence of Great Britain" was scrapped and in its place Bomber Command took over control of all bomber squadrons and Fight Command of all fighters, army co-operation squadrons and the Observer Corps. To Coastal Command was allocated flying boats and general reconnaissance squadrons which worked mainly with the Royal Navy and also the administration ashore of squadrons of the Fleet Air Arm which composed the shipborne aircraft operating with the Navy. Training Command was made responsible for all training units. The RAF was thus organised on a war footing at home into three operational commands and one non-operational, the basis of which was that units were grouped in accordance with their duties. To strengthen the reserve situation a Volunteer Reserve was formed, initially capable of training 800 pilots annually in centres close to important cities, as well as various classes of air mechanics.

Since 1924 units of the RAF normally embarked in carriers and battleships had been known as the Fleet Air Arm. Naval officers provided 70 per cent of the flying personnel, the RAF 30 per cent. Supplies and repairs were organised by the Air Ministry, but the Navy exercised complete operational control. In 1937 the Admiralty was given full responsibility for the personnel, aircraft and shore bases of the Fleet Air Arm. Its first line strength of 181 aircraft in 1936 was replanned to reach 350 in 1939; its personnel was to increase from 3,000 to approximately 10,000 officers and men. Six aircraft carriers and two seaplane carriers were insufficient for the needs of fighter planes, torpedo-spotters, dive-bombers, floatplanes and amphibian flying boats. Building began on a further six aircraft carriers, of which the *Ark Royal* was one.

Types of aircraft new to the service were on show at the Royal Air Force Display at Hendon in June, 1936. *Hurrican* and *Spitfire* fighters made their first public appearance and prototypes of the *Vickers, Wellingtons,* Armstrong-

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Whitworth *Whitleys* and Handley Page *Hampden* bombers were demonstrated, together with the lighter Fairey *Battle* day bomber; the Westland *Lysander* army co-operation monoplane was there too. Among technical developments, the automatic pilot "George" had solved many of the problems associated with long distance flying, while incorporation of eight guns in British fighters and of power-operated turrets with a battery of machine-guns in British bombers was to change the whole tenor of air combat. But information on both points was then a closely guarded secret and, as the result showed, it was kept. To train aircrews in day and night flying, navigation, wireless, blind-flying, bombing and gunnery, the RAF selected the twin-engined Airspeed *Oxford*, and for high-speed practice the Miles *Master*. The results of their training were shown in the 18th and last Air Display when under Air Chief Marshal Sir Hugh Dowding's command, the RAF made a mass-formation "fly past" of 260 aircraft, timed to perfection and flying in one great square of 150,000 hp. at 2,000 feet above spectators. With flights flying 50 yards apart and squadrons a hundred, only matchless precision and air sense could have combined such a team in united maneuver.

Meanwhile the combined strength of the RAF and Fleet Air Arm had risen from 1,020 first-line aircraft in January 1935 to 2,031 in 1938, squadrons for home defence numbering 123. But quality was deemed more important than numbers and it was decided that obsolescent types of aircraft must be replaced with all possible speed. A special mission to the United States solved part of the problem. Two hundred Lockheed airliners, which were regarded as a more suitable type than any military aircraft seen, were ordered for conversion to reconnaissance duties, and orders for 200 two-seater North American Harvard trainers were also placed. The use of the Link trainer for teaching blind-flying was also decided upon in advance of its service adoption in America. Other missions followed, and in Canada and Australia *Hampden* bombers and Bristol *Beauforts* were made. Naval flying boats, modified to military requirements, provided the RAF with the *Sunderland*, a monoplane with an overload range of 2,500 miles. The Air Ministry was given authority to buy up to the full capacity of the aircraft industry, so that Sir Kingsley Wood, succeeding Viscount Swinton as Air Minister, was able to double aircraft production before the end of 1938. The rate of output was then between 3,500 and 4,000 aircraft a year—about seven times the pre-expansion figure—for which 100,000 workers were employed and £84,112,000 was the estimated cost that year.

Large as this outlay may have seemed, the means could hardly be too great for the ends in view. The RAF had four roles to fulfil, the protection of Britain; the guarding of our trade routes; the defence of our territories overseas; and the active provision of help to our Allies, both locally and by offensive bombing operations against a common enemy.

To improve protection against low-flying aircraft, the barrage balloon defences were instituted and later increased to 47 units; and since defence was then our chief concern, priority was given to the construction of fast fighters over bomber aircraft. To exercise our bombers whose range had outstretched the relatively short flights possible within Great Britain, training flights of several hundred British machines to the south, center and southwest of France and back without landing were authorised by France in 1939. Not only was this fine training for British pilots but gave a practical demonstration to the people of France of our common problems and of our solidarity with them.

The real race lay ahead. In numbers the Luftwaffe had probably twice the combined strength of the British and French air forces; and many of its pilots had experienced modern war conditions in Spain. Throughout, the Nazi government had never disclosed the size or scope of its various plans for developing the Luftwaffe while, owing to democratic procedure, having full knowledge of the financial appropriations authorised numbers of personnel and other vital information about the British and French Air Forces. But the postponement of war was to prove of inestimable value to the RAF. *Hurricanes* were by then in fair supply; *Spitfires* were following on and our modern bomber types were coming within sight (although the heavies were not to come off the production line until about two years later).

When general mobilization was proclaimed on August 31, 1939, Britain's air strength was still small but growing. Her task was to hold the enemy until she could herself take the lead. Stamina and speed were both required, but the Royal Air Force were confident that they possessed these qualities. They were fortified, too, by the knowledge that during the years between the first World War and the present they had had the advantages of a central Air Staff concentrating on air problems and the employment of Air Forces in all possible roles. History will pass judgment in due season on the Air Staff, on the quality of their foresight and on the accuracy of their conception in the employment of the RAF. But there are indications already of the value of their work—the high speed eight-gun fighter, the power-operated multi-gun turrets, the speedy ultra-heavy bomber, and last but not least, radiolocation. Two of these with the crews won the Battle of Britain; the other two with their crews have made possible the powerful and successful raids on Germany.

So it is with runners of the greatest stamina and speed who normally start a handicap race from scratch. This sign of their estimated quality may prove a serious disadvantage at first; but there is one compensation. Scratch starters can take the measure of all adversaries ahead, observe their maximum pace, and then, when that pace begins to tell, make their own most determined spurt. Once they take the lead there is little hope for their opponents. Since the day when the Stukas and dive-bombers were mastered near London in the Battle of Britain in September, 1940, the RAF has not looked back. Since then the RAF has achieved parity with the German Air Force. Once again the Royal Air Force has developed that extra spirit which will help to ensure the victory of the United Nations.

END

Medicine

(*Continued from page* 150)

the rudder bar and control column. The test gives a numerical record of the candidate's ham-handedness or lead-footedness. Research with this apparatus has proved that sensory-motor tests can eliminate about one in three of the potential flying failures among those otherwise physically fit.

Increased operating heights have presented aviation medicine with two main problems. One is oxygen supply in the thinner atmosphere of the stratosphere. The other is decompression sickness or "bends," a condition akin to the caisson disease in deep-sea divers.

At heights about 30,000 feet, in aircraft not provided with pressure cabins, the reduced pressure of the atmosphere may cause the symptoms of bends to develop after an hour or more of flight, even though there is an adequate supply of oxygen. Itching of the skin, joint pains, visual disturbances, perhaps localised bleeding of the veins, register the onset of the trouble. If continued further, paralysis, interlogging of the lungs and unconsciousness may ensue. The symptoms disappear when the flyer comes down to about 25,000 feet, except that blind spots, sick headaches and haziness may remain for some hours.

Medical men of the RAF have tackled bends in two ways. One, by a careful selection of personnel to find those most suitable for high altitude flights; secondly by investigating the possibilities of special devices to compensate for the lower atmospheric pressures at great height.

An improved type of decompression chamber has been devised where the atmospheric pressures met with at various heights under varying conditions of temperature can be simulated. Air crews intended for high altitude work are given tests in this chamber before they are allowed to take part in such flights. It has been found that, generally speaking, the sparely-built type is less prone to bends than the more obese. This is because the formation of the gas bubbles takes place more readily in the fatty tissues. It is also established that the longer the flight at high altitudes, say over 30,000 feet, the more liable individuals are to bends. For this reason it is seldom met with in fighter pilots who rarely stay at such heights for more than an hour or so, but it is more common in the crews of stratosphere bombers operating over long distances. Clearly a solution to a problem which affects one of the major strategies of the Allied powers, the long-range bombing of the Axis war production centres, is of first class importance.

RAYON FOR RAIDERS

WHEN our bombers load right up to the limit with fuel—and bombs to drop where they'll do the most good—you'd expect to find a lot of beef underneath to carry them off and bring 'em back.

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That lets raiders (whether heavy bombers or "hot" pursuit planes) carry a little more fuel, slightly larger bombs, or more shells to beat off attackers—and the sum total of those little things counts a lot.

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As to the provision of special pressure-compensating equipment on high flying aircraft two obvious possibilities which British medical science has investigated are the pressure cabin and pressure suits. If an airman wears a special suit, rather like a diver's equipment, in which the atmospheric all round the body and on the lungs can be raised so as to simulate that at lower altitudes, the bends-forming gases are kept safely in solution. But such a suit might interfere materially with the airmen's mobility. There is also the danger, present also with the pressure cabin, that enemy flak might cause punctures. The pressure inside would be lowered rapidly, causing the body tissues, and particularly the lung, to expand rapidly also.

Blacking-out in high speed flight first became a problem to RAF medical men during the training flights for the Schneider Trophy in 1929, won and finally held by Britain. Aircraft had then developed sufficient pull to produce centrifugal forces greater than five 'g'—'g' being the weight of gravity on the body—whilst performing sharp turns or pulling out of steep dives at high speed. The sharper the turn or the greater the speed the greater the centrifugal force, or 'g', and the more the effect on the human body. Thus a pilot turning on a 500 yard radius at 300 m.p.h. is subjected to four 'g'. At 420 m.p.h. on the same radius nearly eight 'g' is attained.

The onset of blacking-out under excessive 'g' is sudden, although it does not occur immediately over five. It is due to centrifugal force draining the heart and the brain of much of the blood, which accumulates in the body's lower parts. The lowered blood pressure starves the central artery in the eyes retina, with a consequent loss of vision until the blood is restored by a fall in the centrifugal force.

In the trained and fit pilot blacking-out does not readily occur; and after-effects are not usually evident. The great danger lies in the temporary loss of complete control of his machine, perhaps during a critical manoeuvre such as a turn on the tail of his adversary. Yet if a pilot avoids high 'g' turns he may by his slowness fall a prey to a quicker and more venturesome enemy. So that the solution of that particular problem now achieved by the RAF represents a solid achievement in the air war.

Blackout is obviously more liable to occur with the fighters with whom high speed and tight manoeuvres are common occurrences. Catapult launching and rocket propulsion also offer possibilities of blackout due to sudden acceleration. But generally speaking these methods of flights have not yet reached the stage where the suddenly applied force reaches the minimum of 4½ 'g' which is likely to produce blacking-out.

Night flying has become as important a part of air operations as flying by the light of day. The main weight of British bombing is delivered by the night bombers—*Wellingtons*, *Whitleys*, and big new *Stirlings*, *Manchesters*, *Lancasters* and *Halifaxes*. Fighter pilots fly by night, too, increasingly; intercepting enemy raiders, or "intruding" over their aerodromes across the channel. Darkness, or reduced visibility, has therefore presented aviation medicine with a rich field for investigation and progress, to keep the human factor abreast of the considerable developments in night flying equipment and location devices.

For night flying it is important to select those who not only have good light-and-dark visual adaptation, but good form sense also. They must be able to see and recognise what they see. Various different techniques have been devised to test RAF air crews for night vision. There is the colorimetric test, based on the fact that the normal eye, after exposure to glaring light, returns to normal as regards colour sense in a definite order. Green is the last colour to return. A new apparatus to test night vision has been devised called the "rotating hexagon" capable of testing six men at a time. On the faces of a hexagonal drum are illuminated panels showing various outlines and letters. After first wearing dark glasses the subjects are asked to read the dimly lit rotating figures, and are scored from "exceptional" to "poor." Another device also in use in the RAF is the "rotating stereogram." This apparatus not only tests the visual conception of depth but is employed to train and correct eye muscle defects with considerable improvement in the landing performances of pilots and pupils.

In addition the RAF Medical Service has carried out a number of experiments to find out what diet and general conditions of living are likely to produce the best results in night vision. The effect of various vitamins and vitamin-complexes has been determined and diets arranged which provide an adequate supply of such aids. It is a point which perhaps requires no over-emphasis, that a vitamin B complex is present in beef, and is also reasonably well provided in beer!

Considerable progress has also been made in the measures taken for dark-adapting the eyes of night flying personnel prior to flight. Part of the process was for them to sit in a darkened room, wearing dark glasses for about half an hour. Under those conditions reading was impracticable. Anyone who has had to wait for a rendezvous with adventure—or even a dentist—knows how trying such a period of inaction can be. Hence the dentist's magazines. Now we have evolved a special type of glasses and a technique which allow the night flyers' "waiting room" to be lit so that they can enjoy their reading, or the racily illustrated pages of the lighter magazines.

Other problems which modern air combat conditions present to the medical men are ocular fatigue, noise, oxygen want, mental and physical fatigue and air sickness.

In the fit individual symptoms of oxygen want, or "altitude sickness" such as dulling of judgment, delayed reaction time, and an unwarranted sense of well-being and security, do not usually occur until a height of about 15,000 feet has been reached and maintained for some 30 minutes. That is, of course, without an additional supply of oxygen. Individuals vary in the degree to which they are affected; and the onset is more rapid if bodily exercise occurs, such as moving about in the aircraft. The greater the height the more rapid, and serious, the effect. At 30,000 feet a man without additional oxygen would "pass out" in three minutes, and be dead in 10 minutes.

Even at 10,000 feet the effects of oxygen want are noticeable if that height is maintained for an hour or so. Crews would find their alertness diminished, their breathing becoming deeper, and a feeling of sleepiness coming over them. Sight and hearing becomes dimmed with increasing height; hand-writing and simple calculation become difficult. The most insidious feature of all is that the victim is oblivious of the fact that he is suffering from oxygen want. In such a state a high-flying bomber would be an easy prey for the first enemy that came along; and the importance of an adequate and unfailing supply of oxygen is apparent.

From this brief outline it will be seen that there is a connected problem of oxygen want during parachute descents from great heights. If an airman bailed out at 35,000 feet, cut off his oxygen supply and at once opened his parachute he would take about 10 minutes to reach the safety zone of 20,000 feet. By the time he would probably have died of anoxia—want of oxygen. He could shorten the time to the safety zone by doing a free fall, covering say the first 15,000 feet in one and a half minutes. But there is the danger of his becoming so short of oxygen in the effort of getting clear of the aircraft and in the subsequent drop as to forget to pull his ripcord in time. To overcome that difficulty the RAF medical branch has devised a light portable oxygen set which will see a man through to safety.

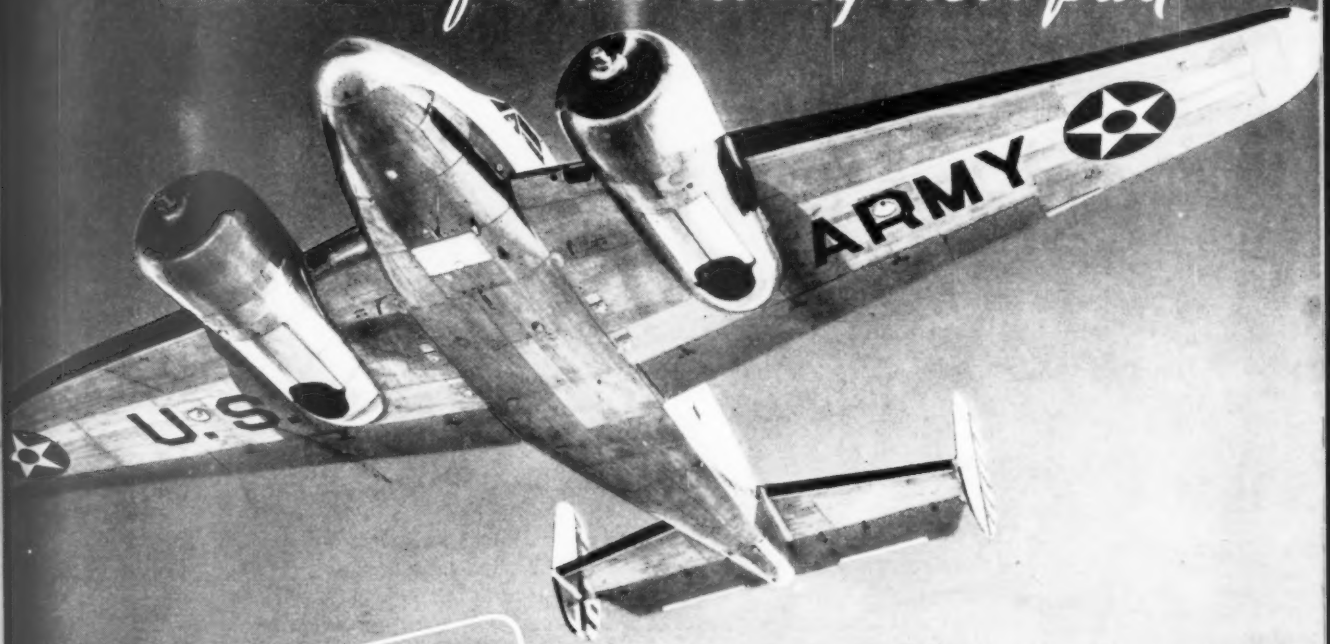
Tied up with the trend towards greater operational heights is the problem of protecting air crews against cold. In terms of physics and meteorology the air temperature decreases on an average one degree centigrade for each 500 feet ascent up to 36,000; thereafter it remains constant at minus 55° C. throughout the year. A mental picture of the conditions at such a common operational height as 30,000 feet can be formed by visualising the eternal ice and snow on Mount Everest.

Continued exposure to cold causes a lowering of the body temperature, slowing up of circulation and respiration, and perhaps arteriolar spasm and pain followed by local "death" of the tissues affected—in other words "frost-bite." Hands, feet, nose and ears are affected first.

Research has shown that the most satisfactory protection against cold in aircraft is by an efficient cabin heating system. Retention of body heat can be secured also by wearing suitable flying clothing; or by providing additional heat through electrically heated gloves, boots and clothing. Hot drinks and carbonhydrates taken frequently, and regular

(*Continued on page* 196)

Beechcrafts are doing their part



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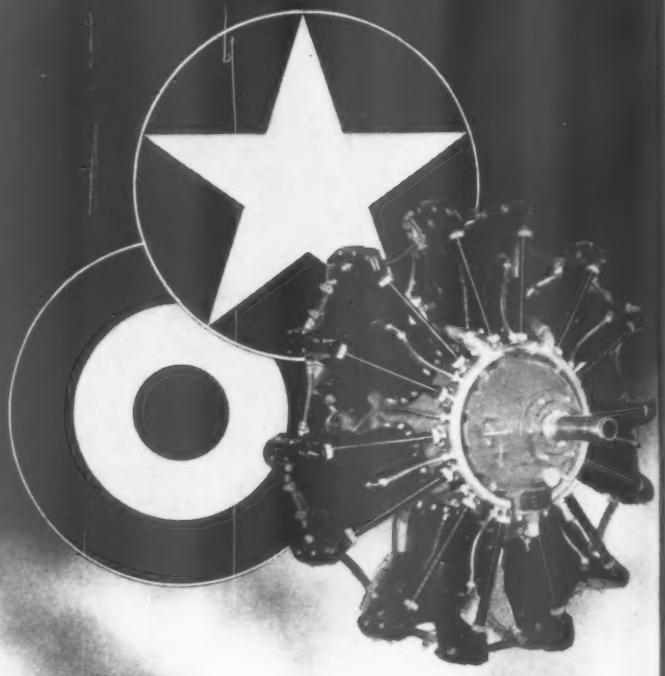

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(*Continued from page* 190)

movement of the limbs, increase heat production and stimulate the blood flow.

In this field again the RAF has had the benefit of medical research; and a new type of flying clothing, non-restricted and affording the maximum protection, is now in use.

Those are some of the major medical problems posed by modern aeronautical progress. Less serious, but important just the same, are the problems of flying and noise fatigue, glare by day or night, and air-sickness. To each some remedy or partial counter has been provided as a result of medical research. A predisposition to air-sickness has been shown to be caused by such factors as cold, discomfort, vibration and noise, diet and smell. Elimination or reduction of those causes is mainly a matter of aircraft design. Precautionary measures include rest, evacuation of the bowels before flight, and a good meal without fat eaten slowly about an hour before taking off.

An ever-present care of the doctors is the maintenance of the human endurance factor. This covers the whole field of physiological and psychological research; and of straight-forward, day to day medical and surgical attention.

Under wartime conditions the human endurance factor is as vital as, or more vital than, the mechanical factor. With operational flying crews this is not merely a matter of being good for so many hours flying. Under peace conditions a man can go on more or less indefinitely. The log books of civil and military air pilots show that they have done many thousands of hours flying with only short breaks. Wartime flying is a different proposition. After a few hundred hours, dependent upon the type of machine flown, the particular duty, altitude, enemy action and individual characteristics, pilots and air crews show signs of wear. They have to be given a rest.

This wearing down of the combat flyer is due in part to the strain on the body caused by the excitement of the chase and the subsequent action with the enemy. In a fighter pilot, keyed up to the limit during pursuit and combat, the whole nervous system is excited, partly due to stimulation from special body glands, in particular the adrenil gland. This is the pep "shot" into the blood stream which under sudden excitement produces definite physical effect — the goose skin and hair-on-end caused by a sudden fright. It is reputed to be specially evident in Italian flyers, who make good fighter pilots—for a short time—and whose motto is "Gone with the Wind."

In air fighting excessive and repeated stimulation of certain endocrine glands, and of the nervous system, leads to nervous and bodily fatigue unless adequate rest is given. For this reason the RAF doctors see that fighter pilots get adequate rest during their operational work and proper breaks, that is, long spells of leave or changes of duty, in between operational tours.

Much the same thing applies to the bomber crews. There is the strain of the take-off, and excitement of the journey out; accentuation of adventure over enemy territory where opposition is encountered, then the climax over the target. On the journey back they are liable to feel unduly relaxed, indifferent perhaps, in the way we feel anti-climax in ordinary life. And such a mood might well spell disaster. It is the squadron doctor's job to guard the flying men from that sort of overstrain. Living with them, taking part in their sports and knowing them personally and intimately, he is able to watch for the signs that a man needs just this or that particular attention. Perhaps a simple change of duty, or even of diet may suffice; maybe a more radical treatment may be needed.

In air warfare, as in sport or athletics, temperament plays a big part in endurance. Cool, calm and methodical individuals make good bomber pilots, whilst the volatile type is more suited to fighter duties. The analogy is the usually different physical and mental make-up of the long distance runner and the sprinter. Pre-selection medical tests made by the RAF doctors help to sort out the types.

This effect of physical and mental temperament on flying endurance helps to explain the differences in the flying capabilities of different nationalities. The Briton's love of sport which inures him to excitement and to sudden emergencies, does much to train his nervous system and endocrine glands to react perfectly, and not to over-function in emergency. With this training he meets triumph or disaster, always cool and efficient.

To this solid foundation of natural flying ability the RAF Medical Service has brought the science of aviation medicine, to the end that British pilots and air crews shall not only be the best trained, best equipped, but also the most physically efficient in the world.

END

Air Intelligence

(*Continued from page* 141)

things is built up the huge shadowy jigsaw which is our picture of enemy territory. It is rarely that any one agent gets the whole story, but when fragments from a hundred different sources are pieced together it is surprising how near the truth, if only in small areas, the great jigsaw comes.

In the early days of the war when the rulers of Italy still concealed their enmity, an English air force officer (in mufti) was travelling through the northern provinces. The two Fascist militiamen in the window seats of the compartment did not give him a second glance. They were talking a good deal and it occurred to the Englishman that one of them seemed to speak his mother-tongue pretty badly. He was, in fact, a German, and it soon became clear from the talk that he was a pilot whose job was to give instruction to the Reich's furtive ally. For half an hour the two men swapped stories. So far, though there were quite a few points of interest, the English listener had heard nothing very startling. But now the Italian began to feel a bit sore at the German's boasting, so he thought up an awkward question or two. "Why do you always fly to the Shetlands?" he asked. "You don't seem to do much when you get there." The German shrugged his shoulders. "Those are just test flights," he said. "It's the longest landfall we can get. If we strike the coast at the point we're aiming for we know this new radio method of ours is working all right." Those words, which meant little or nothing to the officer who overheard them, were accurately reported to London. Together with other facts, they enabled a hitherto unsuspected line of German research to be deduced and anticipated. If the Germans later found that their "bombing on the beam" did not always produce the results hoped for, the reason lay in the fact that a few unguarded words had been overheard in a neutral land.

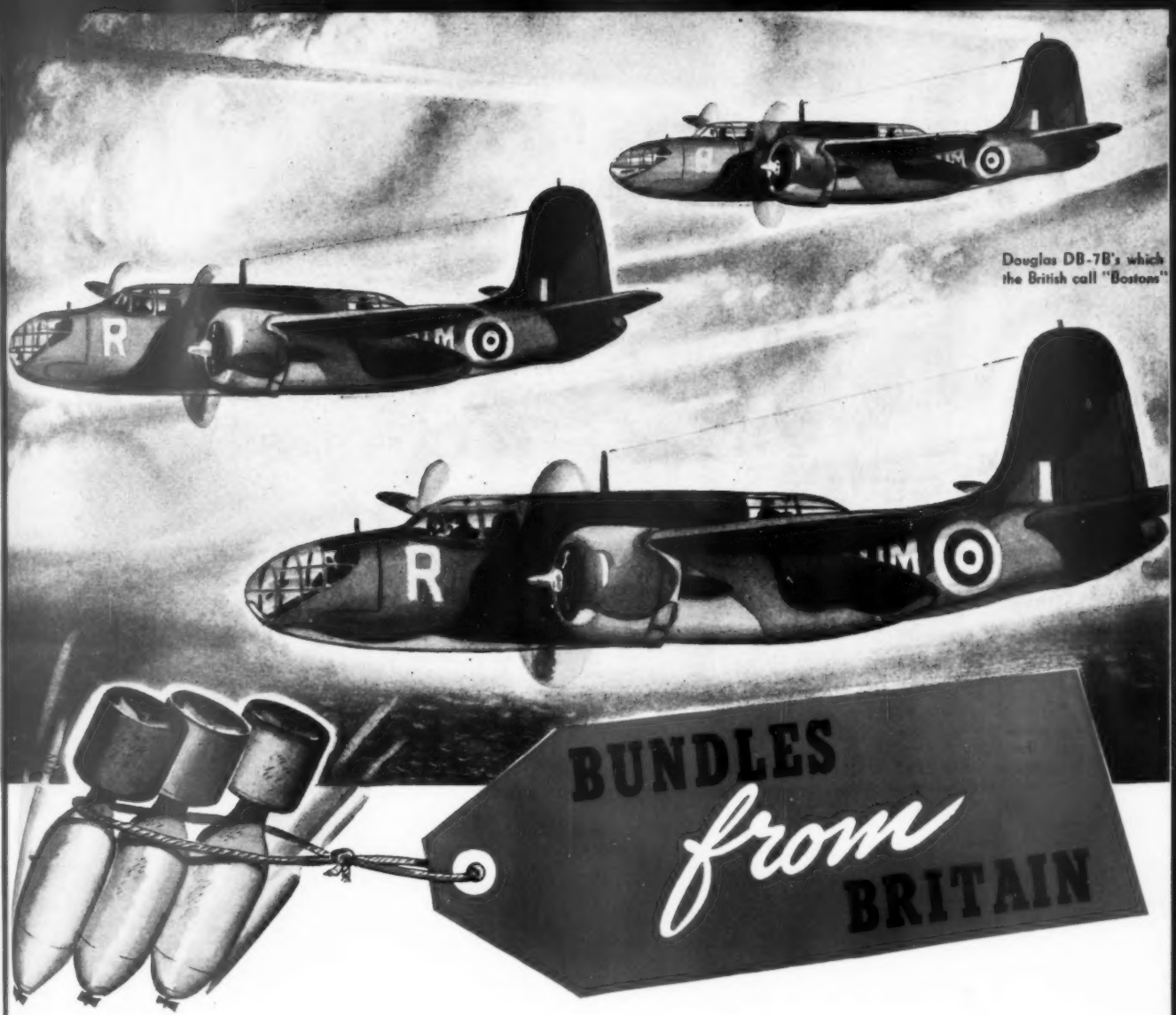
Intelligence is built upon small indications of this kind. Let us suppose that the morning papers report that a strong force of bombers have raided the industrial town of Mitteldorf. No reason for the raid is given and probably few of the public wonder why it was made. Mitteldorf is in Germany and that is good enough for them. But with a limited number of bombers and all Germany, more or less, to choose from, the Bomber Command on this particular night selected a certain town; and this was not done without much hard thinking, and the examination of a mass of data.

To trace the origins of that operation we must go back three months when a copy of the Mitteldorf "Zeitung" reached England through Switzerland. One unobtrusive paragraph attracted an intelligence officer's attention. Herr Schmidt, head of the S.U.V., a small but prosperous local engineering works, had made a speech at a dinner. While no specific matter was enlarged on—that, of course, would be forbidden—the general tone suggested optimism; he conveyed to his shareholders and fellow townsfolk that the firm had just done a good stroke of business.

A few weeks later came another scrap of news. A chance sight of a letter in a South American office revealed that the K.U.G. Company of Cologne regretted their inability to deliver a large order for precision instruments. This was a point worth noting, for Germany had been making strenuous efforts to supply her South American customers and this order could only have been laid aside for a good reason. Soon another interesting point crops up. K.U.G., though not directly linked, is recorded as having sometimes in the past sub-contracted to S.U.V. of Mitteldorf. The file is consulted; the newspaper cutting hinting at S.U.V.'s expansion is found. Not much to go on, perhaps, but it is enough to ensure that a special watch is kept on the Mitteldorf area; and sure enough, it is not long before other facts come in.

They are quite small items individually, but they add up. A German businessman has been in Berne trying to persuade skilled watchmakers to take jobs in Germany. He comes from Mitteldorf. There trickles through from a Swedish source the information that trains are being held up outside Mitteldorf while heavy goods traffic is shunted on to the branch line

(*Continued on page* 200)



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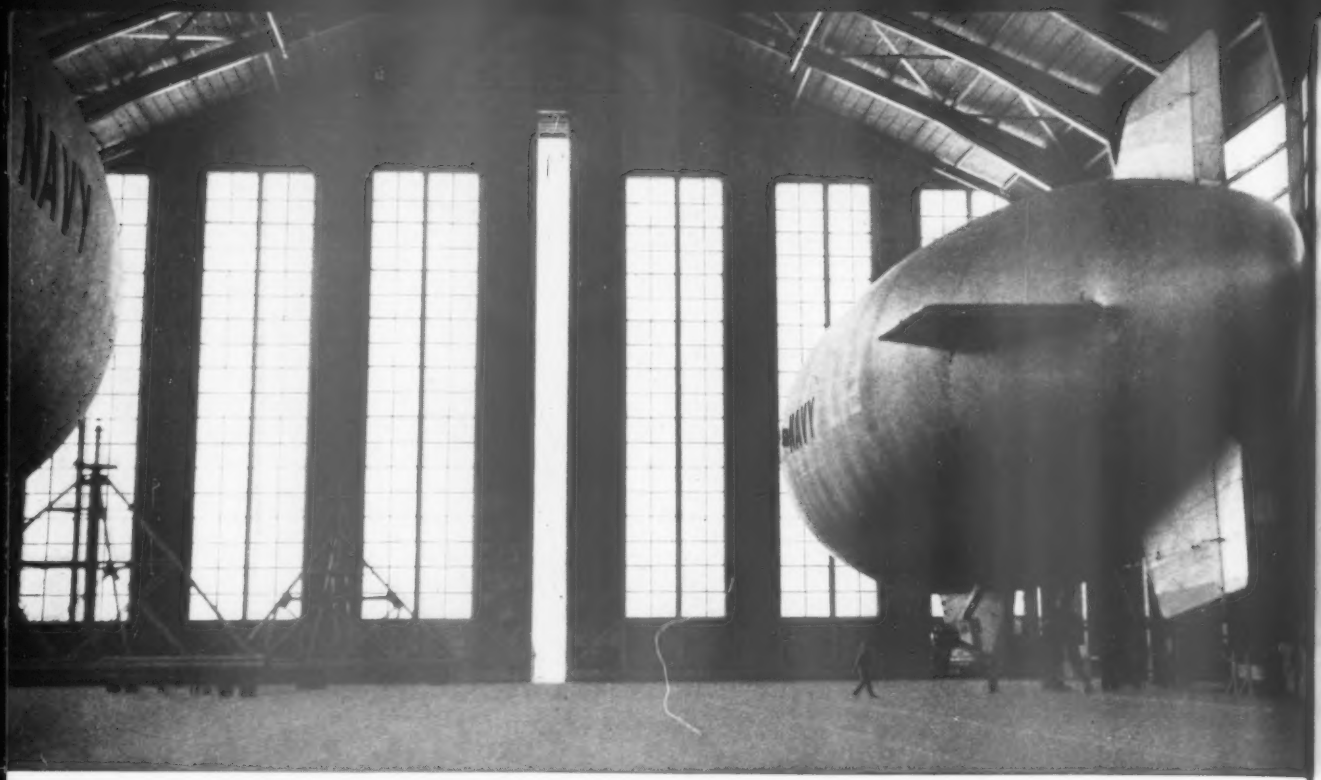

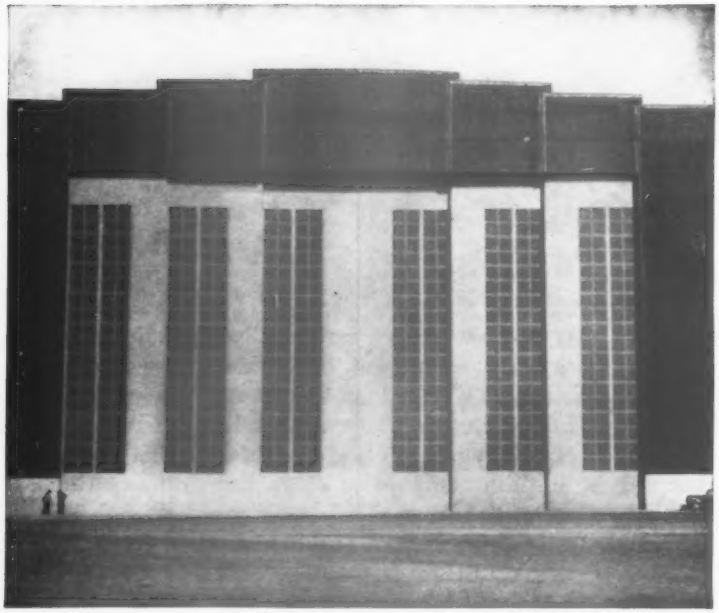

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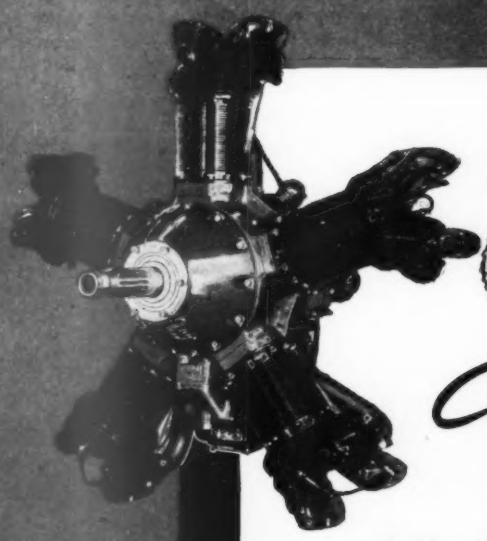

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(*Continued from page* 196)

to Kleindorf, about 10 miles away. A letter found on a prisoner of war states that his wife hopes to get work in the new factory at "———." The censor has struck out the name, but the soldier comes from Mitteldorf.

At this stage a photographic reconnaissance is ordered. A fast plane, flying at a great height, takes a complete series of pictures of the Kleindorf area. The pilot may have a near shave getting them; on the other hand the enemy may never know that he has been over. They are pieced together into a mosaic, enlarged, scanned through special lenses, and subjected to expert interpretation.

The layout of a factory is clearly visible, but it is rather early to decide what its functions may be. In course of time other pictures are secured which are sent to specialist engineers who suggest without knowledge of the facts already gathered, that it is a specialised high grade component which is to be manufactured there.

At about this time an enemy bomber minelaying in an estuary crashes on a mudflat and is salvaged, though in very damaged condition. Fragments of the casing and certain parts of a new type of instrument among the salvage are pieced together. The markings are partially obliterated but lengthy enquiry establishes their origin in Mitteldorf.

The dossier is complete. Mitteldorf is marked down as worth a visit; but there is still a good deal of work to be done. The best way of reducing a factory's efficiency may not be direct bombing. Some plants are too small to be good targets; others are so big that it is difficult to select a vital spot.

In the case of Mitteldorf a balance is struck at last and the scale, method, date and exact objectives of the attack are decided. The affair then becomes a matter for operational control.

In the stages by which the raid originated, one fact is important. The details on which the gradually forming picture was based did not arrive neatly separated and easily detached. They were part of a vast flow of information. Each significant fact was embedded in a mass of useless or even misleading material; and what has appeared in this summary as a relatively simple, almost geometric, process of logic, has meant for a good many expert minds long hours of patient research. Collection of information is comparatively easy; interpretation is another matter. This consists largely of bringing together in correct groups large numbers of facts which seem at first sight to have no common factor. Of a thousand items reviewed only two or three may prove relevant; to track them down by means of systematic indexing is itself no mean feat; to give them a precise value when you have found them is even harder. The human mind tends to find what it is looking for, and from the same huge file three or more experts have been known to draw utterly contradictory conclusions. Hitler is about to attack Turkey; he is going to attempt a landing in Syria; he is massing for an air-borne attack on Cyprus—each thesis is clearly set out and the facts supporting it well-mar-

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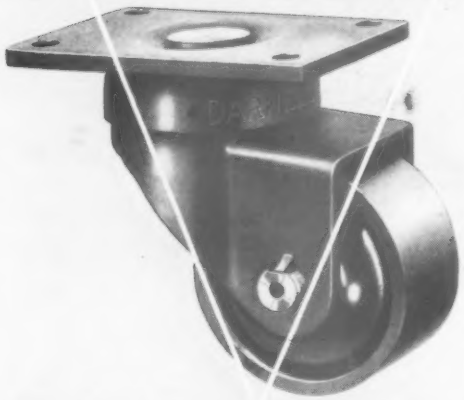

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shalled. Taken alone any one of these three theories would appear conclusive; view them together and you begin to doubt the power of the human mind to achieve anything but self-deception.

And then the decisive fact turns up—the single extra grain which crystallises the whole solution. It is anxiously examined from every angle; its authenticity put to all possible tests. The conclusion which it enforces appears certain; but there must inevitably remain a margin of doubt. When the Intelligence officer has made his recommendations, it is for the Air Staff to act as they think fit. On the strength of the jigsaw of facts provided, the disposition of operational units must be based—a responsibility which it takes courage to shoulder, a decision from which the gravest consequences may flow.

That is merely one example of Air Intelligence work. What are its general aims and accomplishments?

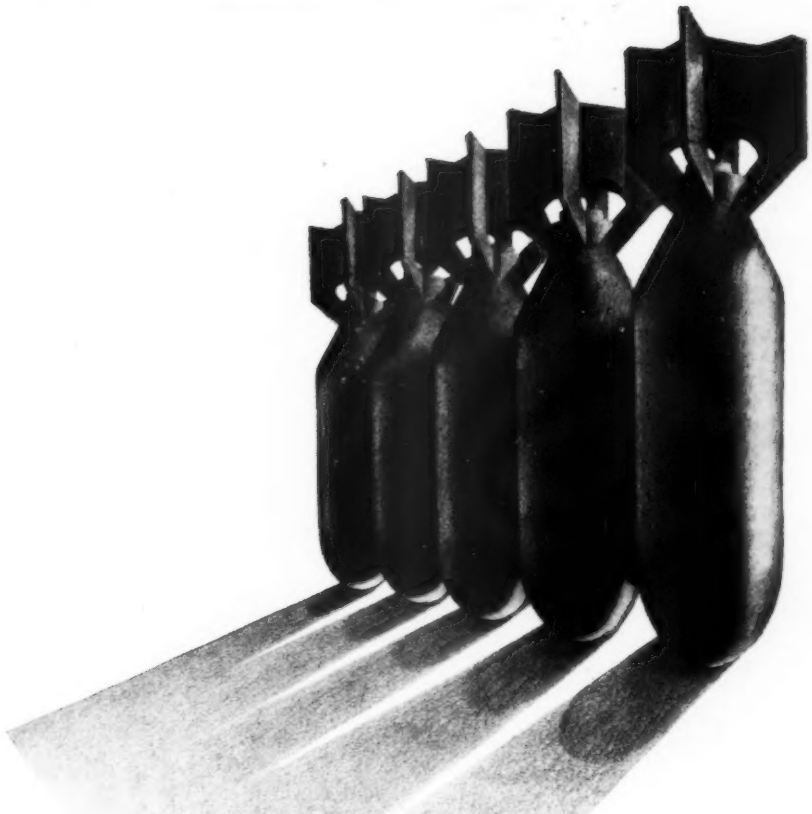
The main function of Intelligence is to discover the strategical plan of the enemy. Besides this, the Intelligence staff must assess the strength of the enemy's internal economic system, what his production of guns and ammunition may be; the depths of his reserves and the extent to which his battle strength can be maintained. An estimate must be made of the enemy's stores of food and raw materials and the morale of the civilian population must be gauged. Shipping, road transport, locomotives and rolling stock—these must be assessed not only numerically but in terms of probable efficiency. Without these factors clearly defined it is impossible to draw up a strategical or economic plan to defeat the enemy, nor is it possible to dispose our own forces to best advantage.

This is Intelligence in its widest sense. The picture of the enemy's position thus formed is termed an "appreciation." Examples of right and wrong appreciations may be clearly seen in Russia's accurate estimate of German strength, and in Germany's complete failure to gauge Russia's capabilities.

The strategical aspect of Air Intelligence is of the utmost importance since the Air Force is at present the only weapon we possess which penetrates into the heart of Germany. But this is not its only function. The RAF, besides defending England against the Luftwaffe, must also assist the Navy to protect the country's seat arteries to America and the Empire; and though the value of air offensive is easily appreciated in general terms, it is not enough for the Germans to be hit hard and often, they must be hit in the right place. The task of Air Intelligence is to discover Germany's solar plexus, naturally heavily guarded, and to advise how to evade the guard without incurring the risk of knockout on the way. Germany herself has helped England to discover the ways and means of reaching the solar plexus—or at least of how not to reach it, which is almost as useful, for during the blitz on England in 1940-41 we got first hand information about what bombing could and could not accomplish. The lessons learnt are turned to good account against Germany.

We now know not only the weak spots in the enemy's economic structure: we know which of these our bombers can tackle. Targets which from an economic standpoint should be destroyed, are often unsuitable for bombing, either because the bomber finds it hard to see them at night, or because they are not easily destroyed by bombs. But we have learnt how to select a target both suitable for the bomber to hit and worth while to destroy. Rostock was a practical example. It was a thriving industrial centre and advertised as such by the Germans themselves in a lengthy article in their illustrated press published shortly before the attacks took place. Moreover Rostock being on the seaboard of the Baltic was easy to find, while strategically a successful attack would cripple a port used by the Germans in their war against the Russians and dislocate an entire section of the enemy aircraft industry. Clearly a desirable target from every point of view. Rostock was selected and the job well and truly done.

But once a target has been selected pilots must be advised how best to avoid the defences of the enemy, whether searchlight, flak or night fighter. Each pilot on his return is asked to give a detailed account of what he has seen and done during the operation so that it may be sifted and analysed. Gradually a picture of the enemy's defence system is built up. Decoy targets, dummy fires and dummy towns are conscientiously plotted. Bomber crews are briefed to avoid traps designed to



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destroy or mislead them.

Fighters operating over their own country do not need so much information as bombers, but what they do receive must be concise and accurate. In combat a fighter pilot has little time to think. Aircraft recognition must be instinctive. When any new type, either our own or the enemy's, comes into service full details must be circulated without a moment's delay. Further, every fighter pilot must know the most likely tactics of the enemy, where they are likely to be met and the performance and manoeuvrability of their aircraft. If engaged in low strafing in enemy territory he must know where all the ground defences are and how to avoid them. The Intelligence staff builds up this picture from photographic reconnaissance, from pilots' own reports and from any other sources of information.

Aircraft operating over the sea are just as dependent on accurate and timely information as our fighters or bombers flying over land. For example, a Lockheed *Hudson* flying from the United States to Great Britain may sight a U-boat on the surface somewhere in 20°W. The captain reports it at once to the intelligence officer of his station. He in turn informs the operational staff. But suppose a second report comes in—pin-pointing a U-boat in a position fairly near to the first, but too far away for the same sweep to cover easily; and hardly is this plotted, than other, somewhat conflicting, reports arrive. Much will depend on the speed and clarity with which the intelligence officer does his thinking. Is it the same U-boat several times reported or are there a group of them? An intensive search of one small area may mean that others must be neglected. Skilled deduction determines whether that sweep finds the U-boat or not. Perhaps the U-boat may be attacked and damaged, leaving oil streaks in its wake. The information is passed back to the intelligence staff, and the hunt continues. New crews go out until the miscreant is finally destroyed or until its escape is regretfully admitted to be beyond reasonable doubt.

With the vast forces deployed in the war today accurate and speedy information is essential if comprehensive plans are to be drawn up. On the intelligence staff of the RAF lies the responsibility for evaluating and disseminating in an accurate and digested form a mass of information from every conceivable source and to place it before the commanders in a form and manner in which they may use it for planning their operations.

The widespread disposition of the RAF throughout the world makes this no simple task. But Air Intelligence never sleeps and the specialised information needed is supplied continuously day and night to commands throughout the world.

END

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Salon Section all by the Air Ministry. Colour Section, all by Air Ministry except "Hornets" by Douglas Aircraft Corp., and the Consolidated "Liberator" at the top of page 116, by Rudy Arnold.

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RESEARCH SPEEDS WAR PRODUCTION

Training and Manpower

(*Continued from page* 110)

structor must decide whether his pupils are temperamentally fitted to make a pilot, and if so whether a fighter or a bomber pilot. Pupils with a pronounced element of dash in their make up, allied to an extreme sensitivity of control and quickness of mental reaction are recommended as fighter pilots. On the other hand, pupils who exhibit coolness, stamina, tenacity, initiative and power of leadership should make good pilots for larger type aircraft.

Learning to fly demands a great effort on the part of the average pupil, but the moment comes at last when he is told to "take her off" alone. Pupils' impressions of their first solo have been variously described, but perhaps the most predominant feeling is a great desire to justify the confidence of the instructor and not to "boob" the approach and landing.

By the time a pupil leaves an E.F.T.S. he has learned the element of flying, can safely control a trainer aircraft, and is well grounded in a variety of technical subjects. He has acquired a "feel" for the air, and must now learn to develop his skill in handling an advanced type of trainer at a service flying training school.

Potential fighter pilots are sent to a single-engined S.F.T.S. and will fly an aircraft which reproduced the main features of the *Spitfire* and *Hurricane*. Those intended for the large types of aircraft go to an S.F.T.S. equipped with twin-engined aircraft such as the *Oxford* or *Anson*. In either case he will receive dual instruction by day and by night in instrument flying, navigation, and formation flying. Handling an advanced trainer aircraft, as he soon discovers, is a much more intricate and responsible job than flying the simple trainer. There is a large instrument panel to watch, a retractable undercarriage, wing flaps, variable pitch propellers; and correct boost pressures must be maintained. There is also much ground instruction to be assimilated. As experience is gained, the pupil makes cross country flights by day and night gathering knowledge of photography and reconnaissance. Cockpit drill, aerodrome procedure, and signals become instinctive, whilst towards the end of his course he is instructed in air firing and bombing.

His flying times and examinations in ground subjects satisfactorily completed, he is ready to proceed to an operational training unit in Britain, the last stage in his training before being posted to a squadron. He has learned to fly and has gained something more precious than gold his wings. Now he must learn to *fight*.

Until this war started there was a widespread idea that, in the air, the pilot was the only man who mattered. In the last war this was perhaps true. It is still true of short-range fighter aircraft, but in the big complex aircraft that are bombing the German factories and patrolling far out into the Atlantic, the pilot divides his responsibilities with a crew of specialists as highly skilled as himself. The members of an air crew are trained separately up to the stage when they are all proficient at their own job and then, at an operational training unit, they are "crewed up" into one highly trained unit.

We have followed the first part of a pilot's training. We will complete the picture with an outline of the training of the other members of the crew.

The main categories of air crew are pilot, navigator, air bomber, wireless operator-air gunner and flight engineer. There are several categories of navigator varying with the role of the squadrons in which they serve, but basically their job is always the same—to locate their objective and to guide their aircraft safely back to its base again. It is a task that requires intelligence and confidence and a clear resourceful mind.

The pupil who, after his I.T.W. course, is selected as a navigator, passes to an elementary air navigation school where he completes his ground instruction. He becomes familiar with all the equipment of the navigator by practical exercises carried out in the classroom, known in the RAF as "Dry Swims." He is then posted to an air navigation school. Here

(*Continued on page* 215)

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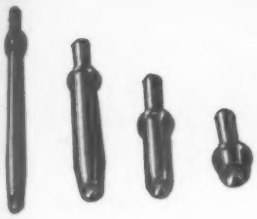

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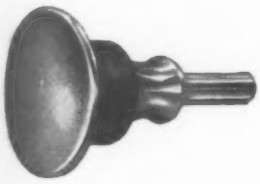

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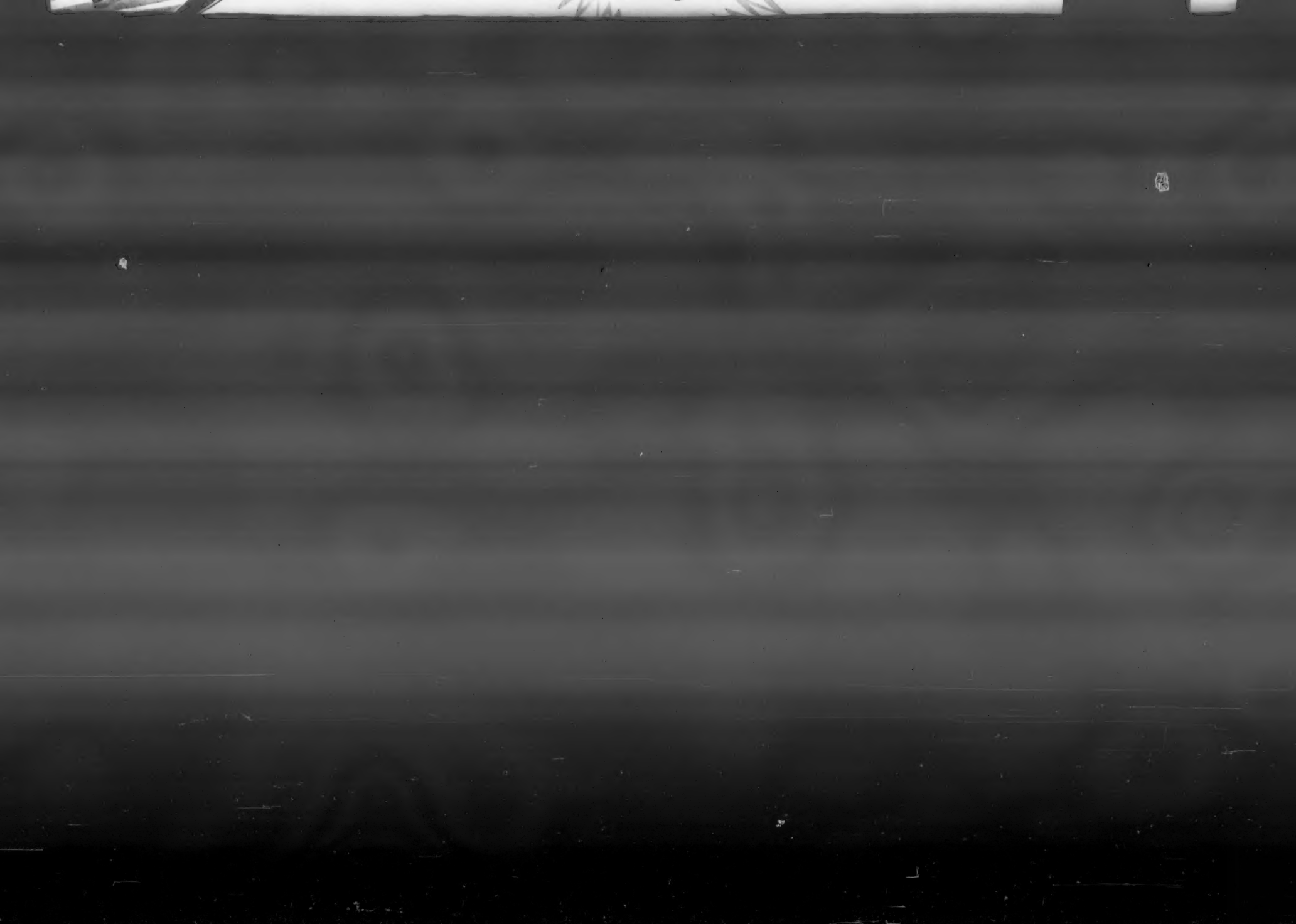

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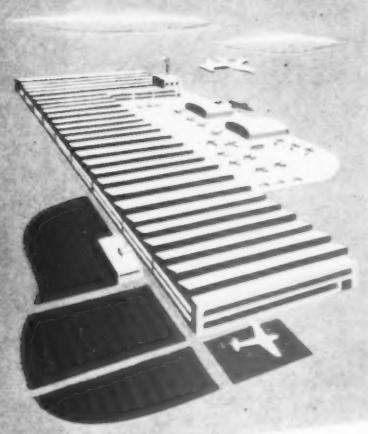

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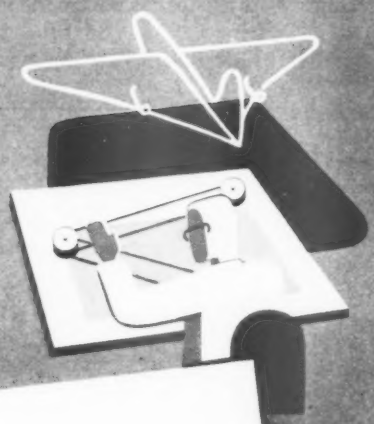

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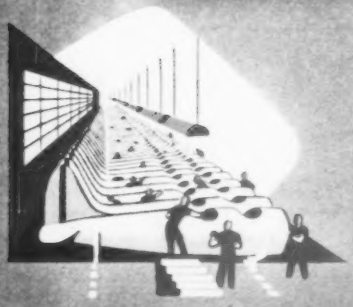

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1922 A Leader in Air Progress for Twenty Years 1942

(*Continued from page* 206)

he practises in the air all that he has learned on the ground, flying at first with an instructor who checks his workings in the air and then, when he has gained sufficient confidence, alone and entirely responsible for the navigation of his aircraft. He carries out cross-country flights by day and night, in good weather and bad, and when he leaves his A.N.S. he is a fully qualified navigator. He has gained his navigator's "Wing."

Before going to their operational training units, some navigators go to armament courses, others to wireless courses, and a pupil destined for Coastal Command is posted to a general reconnaissance school. Here he learns coastal and ocean reconnaissance and special Naval and convoy procedure, and here he must acquire the skill and confidence which will enable him to guide his aircraft to incoming convoys and isolated ships under any weather conditions.

The role of the air bomber is becoming more and more important. Once the aircraft has reached the target area it is upon the air bomber that the greatest responsibility rests. He must identify the target and guide the pilot on his final run-up. Upon his aim and judgment must depend the success or failure of the operation. At an air bombers school he learns the theory of bombing and bomb-sighting, the characteristics of the bombs that he will use, and how to handle his sights. He is given as much practice in the air as possible, for accuracy of aim can only be reached and maintained with constant practice.

The training of a wireless operator-air gunner is long and exacting, for a high standard is necessary. It is carried out in Great Britain and also in Canada. In Great Britain they go first to a signals recruits centre. Here, apart from a general service grounding, their principal task is to learn Morse. They then receive instruction at a signals school in the basic principles of electricity and wireless and the manipulation of wireless apparatus.

Then follows gunnery training. At an air gunnery school they learn how their guns and turrets work and how to manipulate them; they are given training in aircraft recognition and in the principles of range estimation and deflection shooting and they carry out firing practice on ground ranges and in the air until they have attained a high and reliable standard of marksmanship. Then they are ready to go on to an operation training unit.

Finally, there is the flight engineer, an essential member of the crew in view of the increasing mechanical complexity of the modern heavy bomber. His task calls for intelligence, skill and resourcefulness, particularly in an emergency caused by a bullet or fragment of shell in some vital component such as an undercarriage or wing flaps. The flight engineer is a specially selected fitter. He does gunnery and airframe courses, and an engine course on the type of engine he will have to look after during his operational flying.

The pupil coming from overseas to Britain must take a refresher course at an advanced flying unit before proceeding to his operational training unit. This is to accustom him to British weather and topographical conditions, and to night flying under blackout conditions.

The operational training unit is the final and most important stage of the pupil's training. When he arrives there he is competent at his own individual job; when he leaves he is a member of a fully trained air crew, ready to take its place in the front line. While he is there everything possible is done to give him the benefit of the knowledge and experience gained in operations. The greatest lesson that he learns is the value of co-operation—that the striking power of the operational squadrons is the outcome of the unflagging combined effort of the great force that lies behind them, and that the whole fabric of the Air Force is built up on the principle of teamwork—between air crews and ground staff; between the aircraft of a formation—and, most important, between the individual members of an air crew.

At a bomber O.T.U. the members of the air crew are brought together, "crewed up," and introduced for the first time to the type of aircraft which they will fly in their operational squadron. They carry out practice flights by day and night with an experienced instructor, until they are confident in the handling of their aircraft and equipment. Once they are perfect in crew procedure they begin their final tactical training—bombing practice with live bombs, gunnery practice—on the ground at moving targets from portable turrets, and in the air at towed drogues. Signals codes and cyphers and intelligence information must be studied and all the manifold tasks of the crew of a modern heavy bomber assimilated. If they are to specialise in day bombers they must learn the special technique of low flying and navigation. The skill required to reach an objective as far say, as Augsburg, when flying at "nought feet" can only be acquired after intensive training in low-flying navigation. Perhaps low-flying memorisation is more descriptive of the process, for map reading is virtually impossible on such occasions and the aircraft must proceed by means of a string of carefully memorised E.T.A.'s (estimated time of arrival) for well defined landmarks.

The work of a pupil at a fighter O.T.U. is no less arduous. The principle of teamwork holds good as much for a fighter formation as for members of a bomber crew, and the pupil must learn all the technique of tactical formation flying in addition to his instruction in radio telephone procedure and firing air to air or air to ground. Instrument flying, navigation, direction finding, homing practice, aerobatics, air combats, section attacks and interceptions are other matters covered in this intensive course.

Coastal work is so varied in its scope that it is possible to describe only briefly the many sides of this type of training. The Coastal Command pilots fly by day and night, often in weather conditions that would prohibit operations in other commands. The flights are normally of long duration—up to 18 hours or even more—involving long sea passages, more often than not without radio bearings. The training for such work is correspondingly exacting. Dead reckoning is the basis of all air navigation. This particularly applies in Coastal Command, and the captain of a flying boat or landplane who sets out to fly hundreds of miles over the ocean in poor visibility to meet a moving convoy which is maintaining wireless silence must be fully able to appreciate the difficulties of his navigator, and be able to help him in every possible way. At Coastal Command O.T.U.'s flights are made to isolated rocks and islands far out in the ocean and during these trips bombing attacks are made on floating targets. O.T.U.'s may be concerned with land planes or flying boats. In either case the whole technique of Coastal Command work is studied.

Army Co-operation Command has been described as the "eyes of the Army," and its O.T.U.'s are primarily engaged in training pupils in the work of reconnaissance. Thus the first requirement of a pilot is a high standard of navigation and map reading. Here again low-flying technique is being developed, while low-level bombing and air to ground firing in support of troops is also an important side of Army Co-operation work. In addition, an intensive training in air photography, including low level photography, strips and mosaics, is given to pupils. Generally speaking, the first qualification in an Army Co-operation Command pilot, after flying ability, is an aptitude for mental arithmetic, for he must be able to find his way about without wireless aids and to pin point his position while flying very fast at a low altitude.

That is, broadly, a summary of the air-crew training system and its requirements in the RAF today. Ground training is, however, equally important. A highly skilled, highly trained ground organisation is just as vital to an Air Force as its pilots and crews.

In peacetime it took the RAF three years to train an expert fitter or armourer, but war demands an output of trained men to match a mounting supply of aircraft and aircrews. It has been a hard task to meet this demand, for skilled labour could not easily be released from aircraft and armament factories for service in the forces. It is a tribute to the aptitude of the wartime recruit and to the system of RAF trade training, which must of necessity be short and intensive, that men who had previously little or no mechanical experience are now responsible for the maintenance of the most complex aircraft and equipment yet designed.

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each has a basic course of instruction. In addition there are many supplementary courses for duties demanding an even greater specialized skill.

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This vast machinery for training air crews and ground staffs has been built up slowly and steadily from the beginning of the war by unceasing work and willing co-operation. Its justification lies in the increasing weight and effectiveness of the British air offensive. It provides, now, a solid basis upon which to build the Air Forces which will bring us victory.

END

Balloon Command

(*Continued from page* 100)

our balloons have been directly responsible for bringing down a number of enemy aircraft. The first hostile aircraft to be claimed by a British balloon in this war was brought down in June, 1940, by the barrage flown by Balloon Command at Le Havre.

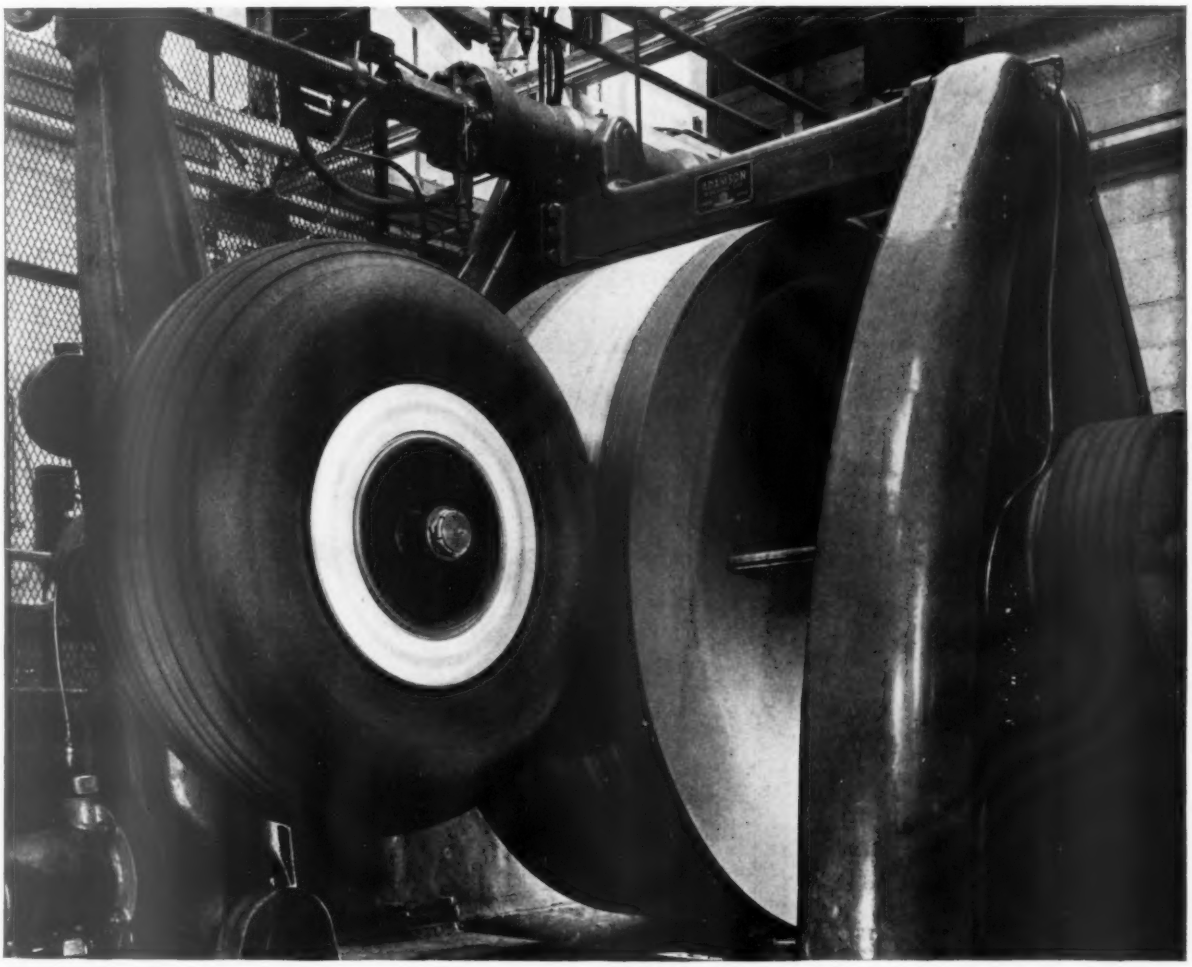
During January, 1942, a new type of German bomber was destroyed in a barrage in the northeast of England. The balloon crew heard the aircraft approaching their site very fast and low; then they heard their balloon cable struck, but it was too dark to see the aircraft. The bomber crashed between one and two miles farther on and the balloon cable was recovered intact. A portion of the starboard wing of the enemy plane had been clearly cut by the impact, and was subsequently recovered from a neighbouring site.

In the small hours of the morning of September 13th, 1940, a Heinkel hit the cable of a balloon flying in Newport, South Wales. The aircraft swung round pulling the cable off the storage drum and then flew on towards another site with the cable clinging to it. The trailing wire fouled the cable of a second site and the aircraft crashed and burst into flames.

Operations in general, however, must be regarded as static, and it is comparatively rare for the crews to have the great satisfaction of catching the enemy in their cables. This form of static defence—keeping the balloon aloft whatever the weather and whatever the aerial bombard-

(*Continued on page* 220)

"COMING IN AT 100!"



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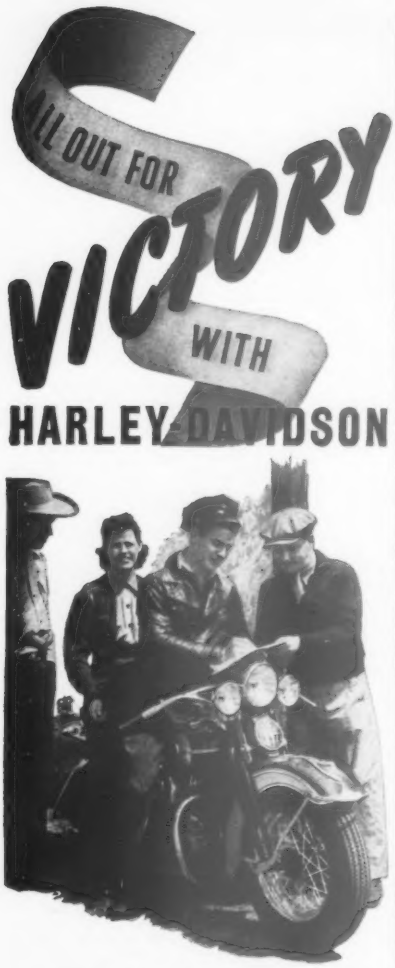

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(*Continued from page* 216)

ment in progress—was never better tested than on the night of November 14, 1940, at Coventry. Here are brief extracts from the report afterwards written by the squadron commander on the spot:—

"The warning was received at 19.11 hours. In spite of the weather risk the barrage commander ordered that the balloons should be flown at operational height.

"The enemy attack commenced at 19.30 and continued with terrific intensity until about 06.30 hours next morning.

"The first raiders dropped showers of incendiary bombs which started fires in the city. Guided by this 'beacon,' waves of enemy aircraft flew over the city, dropping large quantities of high explosives.

"At 20.30 hours telephonic communication broke down completely and squadron headquarters were out of touch with flights and sites. Despatch riders were rapidly brought into service and, under conditions of the greatest difficulty and danger, they worked for the remainder of the night.

"Then came another catastrophe—all lighting failed. Emergency lighting was brought into use at once."

Throughout the night Flight Headquarters and sites were experiencing trouble. The following are extracts from reports:—

"A near miss blew in the windows of flight headquarters and brought down the roof. We had to evacuate."

A pilot officer from "B" Flight Headquarters says:—

"I was making a round of sites; as I left site 17 a bomb dropped about 100 yards ahead bring down two houses. I took the ambulance and picked up a number of people who had been hurt. . . .

"The flight commander went out to where a delayed action bomb had fallen 70 yards from headquarters. He would not allow anyone else to go near it and took care of the boarding-up himself."

An officer at "B" Flight makes the following observations:

"All windows of our headquarters were blown in and several D/A bombs fell within a few yards.

"Huts on Sites 18 and 40 were destroyed.

"When a delayed action bomb fell about 10 yards from the bed of Site 8, the men were in their shelter, but on hearing the balloon cable was falling, they turned out, hauled down the balloon and bedded it.

"In spite of the many casualties and obvious difficulties encountered, the balloon barrage was up to strength and flying by 12:00 hours on 16.11.40."

To complete the protective circles of harbours and estuaries, balloons are sometimes flown from surface craft moored on the water. Water-borne barrages afford not only protection to vulnerable areas and to shipping but also have great value as a deterrent to mine-laying by the enemy.

One Christmas Day the commanding officer of a water-borne squadron, accompanied by his adjutant, set out in a launch to shake the hand of every balloon operator under his charge. Though he stopped nowhere for more than the usual Christmas greeting, this trip took him four and a half hours. This indicates the practical difficulties of maintaining a barrage afloat. Nevertheless, some of the most useful work carried out by Balloon Command is upon the water. Life in the water-borne barrage varies with the geographic situation; but in a typical estuary barrage, the balloons are flown from barges and drifters. Each of these vessels is mobile and keeps steam up day and night. There is a civilian crew for manoeuvring the vessel, and a crew of three or four airmen, with a corporal in charge, to manipulate the balloon. The winch is generally contained in the hold of the vessel and as, of course, there is no means of bringing the balloon down to the deck, it must always remain either flying or else close hauled. A period of 10 days to a fortnight at sea is usual. During this period the crews may be in sight of land, but their only connection with the shore is the daily visit of the ration boat and radio communication. More frequently than any other balloon site, these men have had opportunities of combat with the enemy. Several hostile aircraft have been brought down by their gunfire.

During the Battle of Britain in August, 1940, it was essential that the English Channel should remain open to our convoys. On August 4, a convoy left a west of England port for the Thames Estuary protected for the first time by balloons of Balloon Command. During that first trip, and during nearly every subsequent passage, balloons were attacked by Messerschmitt fighters. Through rain, snow, ice and fog, c in gales which threatened to tear the winches from the decks, the RAF crews of Balloon Barrage vessels have now made well over 100 trips. It goes without saying that these men have seen more action than any other balloon crews, and as proof of their services there are, at the time of writing, already 10 honours in the Flight which operates the sea-borne balloons.

Enemy fighters are not the only resistance encountered. Shells from the German batteries are often observed. On one occasion one of them severed a balloon cable.

The following extracts from the log of an RAF officer on a balloon barrage vessel indicate the variety of the hazards they run:—

"*09.50 hours.* Mine sighted on port bow necessitating sudden change of course. This was followed by sighting other mines on the starboard bow until eventually we zig-zagged through 23 of them. Obviously they had broken loose during the storm.

"*11.05 hours.* An Me-109 made two machine-gun attacks on ——. Shooting bad and no hits —— attacked by four dive bombers. Bombs could be seen hitting the sea beside the ship.

"*18.56 hours.* Vivid flashes from French coast.

"*21.43 hours.* Enormous flash from French coast followed some 80 seconds later by the sound of heavy explosion.

"*22.24 hours.* A. A. fire from French coast. Throughout the night there was

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a series of flashes and occasional A. A. fire from both coasts.

"*Thursday, 02.20 hours.* This has been written subsequently as things moved too fast to record them at the time. I came below to call my relief and as I came on deck I was told that a motor boat had been heard on our port bow and had disappeared. About five minutes later there was an explosion astern followed immediately by another.

"Immediately the place seemed to become like a gigantic firework display. Everybody who had anything seemed to let it off. Tracers showing up scarlet in the night were returned by bullets, which appeared green in colour. We kept dead quiet. The trouble was, or appeared to be, about a quarter of a mile astern and we were in such a position that we could do nothing effective if we did open fire.

"What actually happened we shall not know till we reach port, but the Motor Torpedo Boat Brigade were putting up flares all over the place. Presently we heard a "phew"—almost next door it seemed, but whatever it was it did not find its mark. After what seemed hours, but was only a few minutes, it seeemed that the firework party was falling astern.

"Personally, I heaved a sigh of relief. By the gun flashes and rattle of machine guns I knew our escort was doing its stuff. But suddenly right on our starboard beam two high flares shot up and came sailing down lighting——and ourselves as clear as day. There followed what we all expected —a sickening thud. We thought the——had got it. Then there was another lull followed by the usual cries of "there she is" as the machine guns opened up again and flares showed us up.

"Our RAF crew, needless to say, are splendid. With all the excitement last night when I went aft, I hardly expected to find anyone at the winch. But there he was—our man who shall be nameless.

"*11.55 hours.* This looks bad. About 30 Junker Ju-87's with an escort of Messerchmitt Me-109's arrived over the convoy. The procedure is simple. The fighters try to put the balloons down in flames, and, like one platoon following another on the parade ground, the dive bombers follow. Whether they saw something we didn't, I don't know, but the bombers suddenly veered away and that was that. But not before our fighters had got a couple of Junkers and possibly a third.

"*18.54 hours.* Alongside quay. Tied up."

There is little doubt that the ever present barrage of balloons in the sky has been a great encouragement and comfort to the British population during aerial combat and bombardment. But it has seemed sometimes, particularly in fine weather, that the work of the balloon operators was easy compared with the more obviously active operations of the RAF.

Among those who have never worked on a balloon site this view has perhaps been encouraged by the fact that women are now employed on the job. But though simplification in the technique of balloon manipulation has made it possible for certain sites to be taken over by members of the Women's Auxiliary Air Force, this simply shows what first-rate work women can accomplish nowadays, and is no reflection on the men they replace. Intelligence, skill and courage are still required; it is only the need for brute strength which technical improvements have lessened.

The training of women began, as an experiment, early in 1941. In July, the Air Officer Commanding reported to the Secretary of State for Air: "Training has proceeded to the extent that it has now been found possible to draft women to war sites in the balloon barrage, which sites they will in a few days' time be in course of taking over from the airmen."

When the first WAAF crews took over sites in the first barrage to be operated by them, it was found that it took 16 airwomen to replace 12 airmen. At the beginning of September, 1941, it was considered that the experiment was successful, and that substitution for men should take place gradually.

When they finally take over in force the WAAF will have a gruelling job on their hands. The maintenance of an efficient balloon service on the vast scale of the barrage flown daily in the British Isles, demands the highest mental and physical alertness and the most careful organization. Under fire it is one of the most dangerous jobs; in winter it is one of the coldest. At all times it is exacting. The constant vigilance which is the price of liberty is demanded in full measure from every service—and not least from those who man the balloons.

END

Man in Action

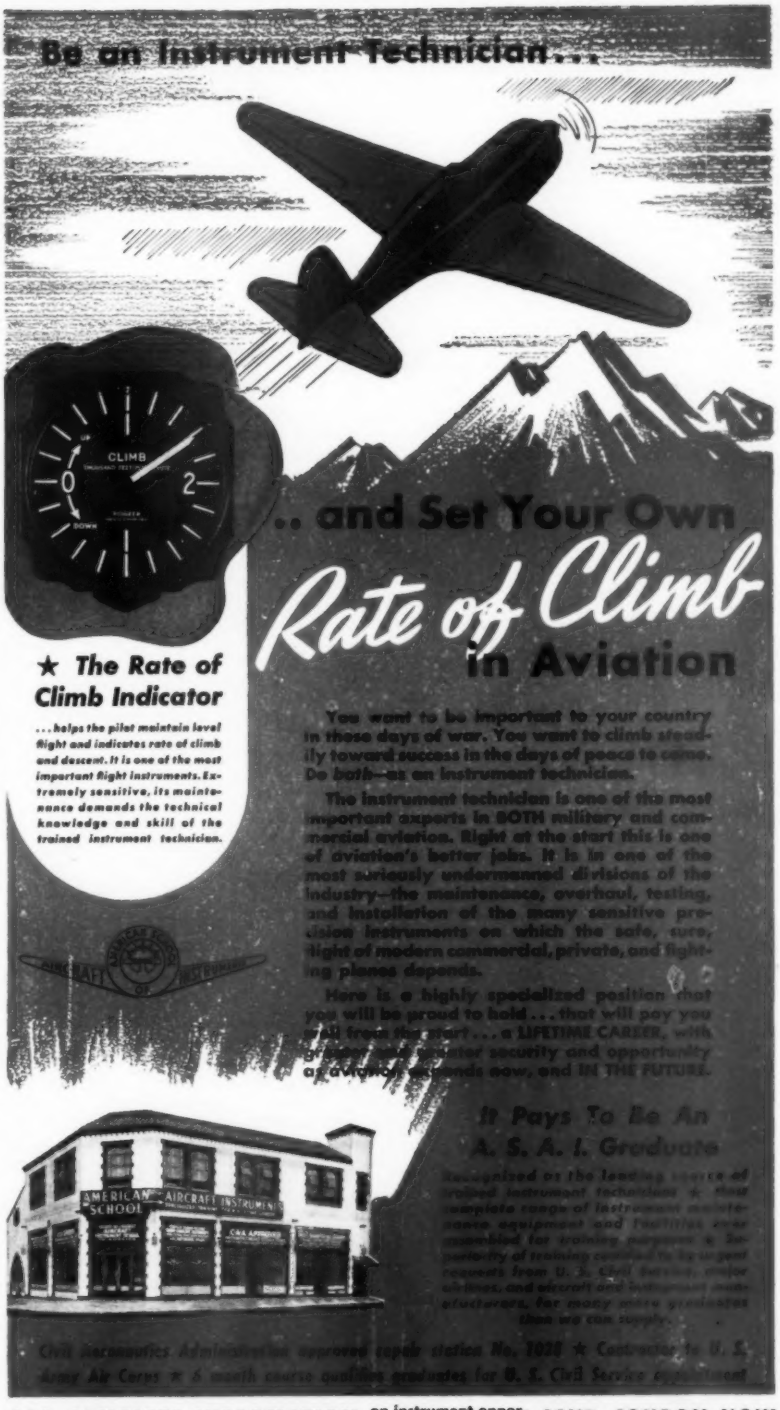
(*Continued from page* 133)

is aware that he depends on them—his navigator, his radio operator, his engineer, his gunner, his observer—not only for his own safety but for the success of his operation. They too are aware of the same thing. In consequence their outlook becomes much more like that of sailors; they are all in the same boat; they depend on the conduct and discipline of each other for the safety and success of their enterprises. Unlike the attitude of the fighter pilot, which is in the finest sense of the word autocratic, theirs is a superbly democratic attitude.

The successes of these men are not individual; they are the successes of units in which individuality is sunk. For this reason, and also because the flights of bombers and coastal planes are often long, dull and uneventful, they are much less publicised than those of fighters. It is only on such dramatic occasions as the sinking of the *Bismarck* and the pursuit of the *Scharnhorst* and *Gneisenau* that the work of Coastal Command suddenly lights up the headlines. But even in such a magnificent feat as the *Beaufort* torpedo attack by Flying Officer Kenneth Campbell V. C. on a battlecruiser at Brest it is significant that the crew, all of them sergeants, are officially given the very greatest commendation. All of them died in that attack, and there are no medals to their names solely because the V. C. is the only British award which may be given posthumously. From this it is not wrong to assume, perhaps, that all of them share in that award.

Flying Officer Campbell, a Scot from Ayrshire, came to the RAF from the University Air Squadron at Cambridge. Flying a torpedo-carrying *Beaufort*, he began to distinguish himself very early: so that he was once pointed out to the Air Officer Commanding by his station commander as " a young man who before long is going to win the V. C." He was very successful and tenacious in attacking shipping; he sank a 3,000 ton supply ship in moonlight, made a direct torpedo hit on the port beam of a 6,000 ton vessel off the Dutch coast. He once attacked strong gun positions on the Dutch coast and was very much shot about in consequence, by two Me's. His wireless operator was wounded, the hydraulics shot away, the gun turret put out of action. He himself was wounded and lost a good deal of blood. He crashed on return to base, his aircraft very badly damaged. But he was very soon out on operations again.

These attacks were examples of the splendid tenacity which finally so astounded the Nazis in the attack on Brest that they could only conceive it as "being due to large quantities of whisky." The concentration of defences at Brest is undoubtedly one of the largest in the world. To attempt an attack there with torpedo-carrying aircraft was an extremely dangerous enterprise. It was almost certain that Campbell would never return. He did not return. It would be more accurate to say that "they did not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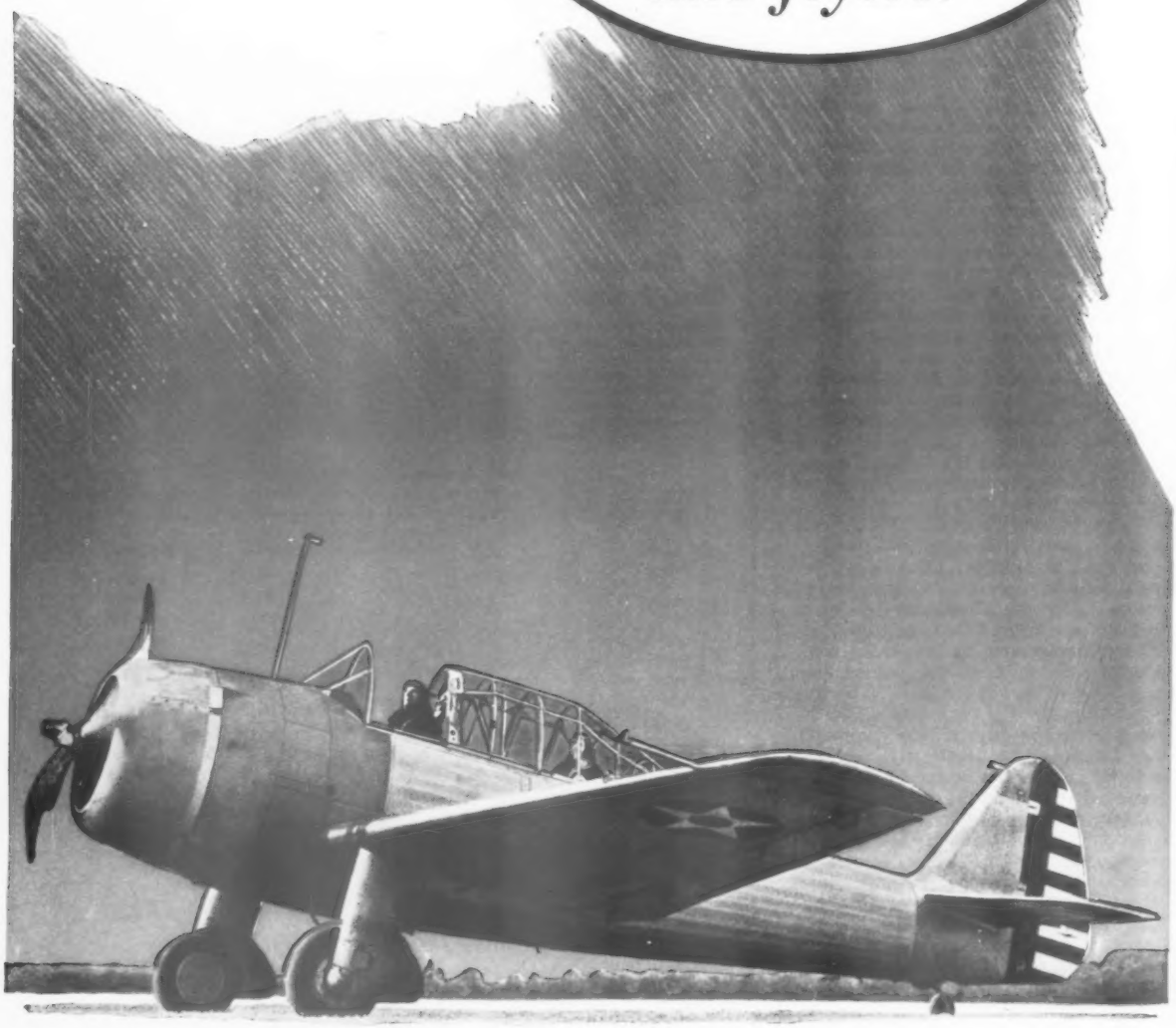

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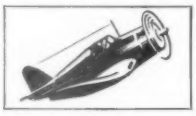

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return." Sergeant Scott, a Canadian boy of 19, Sergeant Mullis, a Somerset farmer, and Sergeant Hillman, a London chauffeur, shared in the fury and glory of an attack they never lived to describe but of which the success has never been in doubt. It is typical of German mentality that the tenacity of those four men should have struck them as being artificially created.

The whole attitude of the bomber pilot in action is very similar. Long journeys in darkness, intense cold, frost-bite, flak that has been described by one of them as filling the sky like the paper streamers of a ballroom, the difficulties of taking-off and landing in darkness: those are a few of the routine problems of the job. There is a popular notion that the pilots of fighters are all very young, wild and volatile, and that the pilots of bombers are older men, dour, cautious, steady. This is not true. There are plenty of instances where the pilots of *Stirlings*, for example, are boys of 19 and 20. Moreover it is not the bomber pilot but the fighter pilot who, in the periods of preparation for action at least, strikes one as being cautious. It is the bomber pilot who, off duty, strikes one as being volatile. The reasons are again quite simple. The fighter pilot must always be ready; his orders to fly may give him less than five minutes to reach his plane. His recreations must be sober, rather limited, never excessive. The bomber pilot, on the other hand, is briefed some hours before he flies. Once his trip is over it is unlikely that he will fly again, except in an emergency, for a day or even two days. And since his trip has occupied six, eight or even more hours, he has accomplished, in one night, the equivalent of three, four or more fighter operations. He is entitled to an equivalent rest. The cold, the vigilance, the danger, the nervous tension of those hours all produce a considerable and sometimes violent reaction. In consequence the bomber pilot, off duty, tends to behave something like a hilarious schoolboy released from unpleasant detention. His life, on operations, is one of violent extremes.

The strain of this violent way of living can be seen in the bomber pilot's eyes. They give the impression of not being correctly focussed. Strain and cold make them rather old and glassy. The eyes of the fighter pilot never give the same impression. Theirs is much more an expression of exhilaration. Their triumph when it comes, is a personal one. But in a bomber there is far less likelihood of a personal triumph. A pilot relies very much on the skill of his navigator; their co-operation is extremely and necessarily close. He relies on his rear-gunner for protection, for information about hostile aircraft and for warning of ascending flak; it is through this information that he can take evasive action. He relies equally on his radio operator, his observer, his engineer. There have been many cases where these men have accomplished outstanding performances, even cases where a navigator, when his pilot has been wounded or killed, has piloted and successfully brought home a plane. But the greatest performances on bombers are probably all collective; the crew are indivisible: their comradship, morale and unselfish tenacity are not equalled in the world.

It is in fact hardship rather than heroism which, in a survey of bomber exploit, seems more remarkable. The story of a *Wellington* crew composed of a pilot officer and five sergeants who spent 57 hours in a dinghy before being rescued is astonishing but not, as an example of fortitude and discipline, unique. The objective of this *Wellington* was Berlin; the cloud over England thickened into impenetrable masses over Germany. It was a night of great difficulties: so that in all we lost 37 bombers. Thirty miles from Berlin the *Wellington* was hit—"we heard a crack and everything in the aircraft shook"—but the flying capacity of the bomber was unaffected. The captain, Pilot Officer L. B. Ergeland, took the plane on over the capital, dropped all his bombs except his incendiaries and then turned back. On the way home the bomber was hit again and almost simultaneously the second pilot, Sergeant D. A. S. Hamilton, and the rear gunner, Sergeant A. V. N. Fry, reported that the plane was on fire. The captain, opening the door behind him, saw an appalling sight. The fuselage was full of smoke: flames were rising through the floor and creeping up the sides of the plane. The racks of incendiaries, not dropped over Berlin because of bad visibility, were burning furiously along the whole length of the plane.

The fight against that fire went on for a long time. From the ground every ack-ack battery in its course fired at the blazing bomber. The pilot tried to jettison the burning incendiaries but the electrical switch would not work. The wireless operator sent out repeated messages. The front gunner carried the orders of the captain to the rest of the crew. The second pilot beat at the fire with the burning window curtains which he had ripped down and extinguished with his hands.

While the crew were fighting the fire in the interior of the bomber, flames had spread along one wing, burning part of it away. The plane had all this time been losing height. It crossed the coast finally at 1,000 feet. And because he liked the chances of the sea rather than the chances of enemy territory, the pilot flew on. Twenty-five minutes after that decision the petrol ran out. The flaming aircraft had been flying for nearly three hours. The cases of the incendiaries were still burning.

When the bomber came down into the sea its back was broken. It sank almost immediately; the flotation gear which keeps an aircraft on the surface for a few precious minutes had been burnt away. The crew scrambled into the dinghy. The pilot had an injured leg, a face badly cut by being thrown forward against the instrument panel. The rest were unhurt.

They waited for dawn and it was a lovely day. The sea was very calm and the sun very warm and about 10 in the morning *Hurricanes* flew over the sea in the distance, not seeing them at all. A plane came over and dropped Very lights, but it was too high for them to

(*Continued on page* 230)

VICTIM

of his father's heroism

The men who face sudden death in the Hurricanes and Spitfires over every British front have dependents at home. Most of them come from families of small means. Many take to the hazardous air knowing that if they are brought down, their children, wives, mothers will barely be able to survive on the government pension alone.

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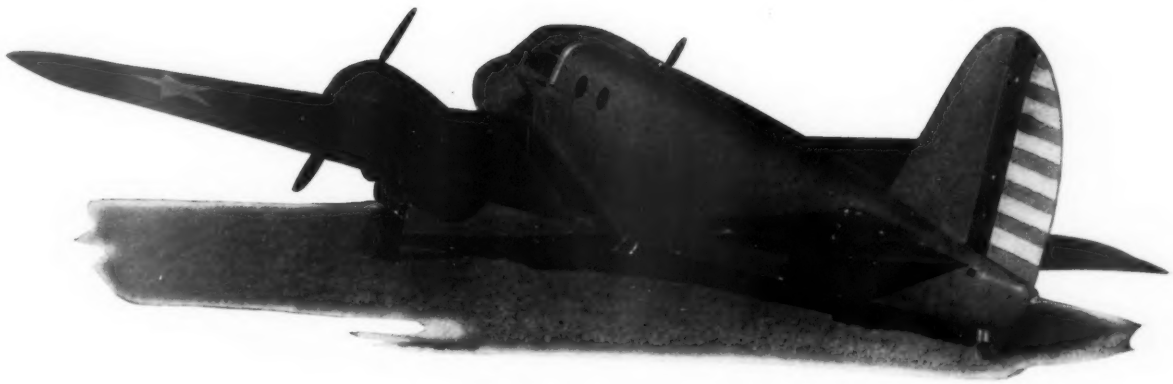

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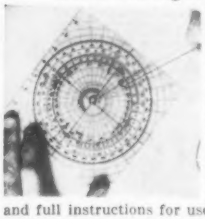

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(*Continued from page 225*)

identify. They paddled all that day and then, taking turns, two at a time, all the following night. The next day the weather was very bad. The dinghy, though always seaworthy, shipped plenty of water, and they baled with tins and their hands. It was colder too and they rationed their food, which was biscuits and chocolate, and their drink, which was rum and water—enough for six days.

That night the wind came up even more strongly. But when the sun came up they saw a buoy go floating past them at "a devil of a speed with the tide." That buoy encouraged them enormously. They saw the coast too in the distance and began to paddle frantically, "like ding bats," for fear of being carried away from it again. They began to be taken ashore very fast and finally they could see people. They waved and the people ashore waved back. They paddled to within 20 feet of the shore and then the seas finally drove them in to the outstretched hands of the rescuers.

The files of bomber operations are full of such stories. The individual details change from story to story. The effect remains the same. These stories are rarely publicized; yet they are the solid foundation which make the great spectacular raids on Augsburg and Brest, Lubeck and Rostock, Skoda and Trondheim, Cologne and the Ruhr, possible. Behind the courageous who are decorated stand the courageous who are undecorated. Who is to chose between them? The whole world has heard of the great exploit at Augsburg of the crew of a *Lancaster;* only a little group of people has ever heard of the Australian pilot with whose story this article began. But between the crew of a triumphant *Lancaster* and the crew of a disintegrating *Stirling* there is really, in the final assessment, no difference at all. Their status is one with that of all fighter pilots sweeping the coast of France and of all *Beaufort* crews torpedoing ships; one with all night fighters intruding over France and all *Swordfish* piling themselves up in the decks of battleships. They have a common and in the end an anonymous name. They are the men in action.

END

Malta, G.C.

(*Continued from page 86*)

aerodromes on the island," wrote an observer. "At some periods today the air was filled with battling aircraft, while at others hundreds of cotton wool puffs of bursting shells floated across the sky." Squadrons of Junkers and Messerschmitts released from the Russian front were increasing the tempo. Life was a dangerous business; though by this time there were more than 6,000 shelters hewn out of the island rock, with nearly treble that number under hasty construction. Most were equipped with electric light and wireless; there was also provision for washing and cooking. In some were small altars at which regular evening services were held.

On the afternoon of Wednesday, March 26, *Spitfires* and *Hurricanes* shot out of the sky a formation of 30 Junkers Ju-87's flying in pairs, the usual protecting Messerschmitts stepped above them. At least half the enemy did not get back, but within a short while a second formation raided the Grand Harbour. This time it was the turn of the anti-aircraft gunners, whose barrage was so intense and so accurate that many of the raiders failed to get through, their bombs falling harmlessly in the water.

The next day came the heaviest attack so far. For six hours wave after wave of Stukas and Junkers Ju-88's showered down high explosive on the defenders. The first wave, 15 Ju-88's, came in at noon on a southeasterly course, swerving suddenly to attack the Grand Harbour; a few minutes later came a similar wave, and then a third. For 20 minutes all hell was loose. Naval ordnance, Bofors and other anti-aircraft units put up a "steel curtain" across the harbour mouth. *Spitfires* and *Hurricanes* ripped wide open the enemy formations. Nevertheless, the damage was considerable.

During the first week in April Malta was facing some 500 aircraft, half of them bombers. On Tuesday, April 7, more than 300 bomber sorties were flown against the island, hostile fighter sorties numbering over 50 more. Hardly a single Italian bomber was seen. The Luftwaffe had taken over.

Then came a lull—that is, the bomber sorties dropped to a mere daily hundred. Kesselring's grand slam was still to come. The Nazi air chiefs were impatient—they were badly behind schedule. On Hitler's birthday, starting with a breakfast time raid, they struck again: then for two days, in full strength, they blasted the island. But the *Spitfires* did some blasting too. Incidentally, an American pilot officer, still celebrating the Fuehrer's birthday the day after, got a trifle rough with a Ju-88 and Me-109, both "probables" being shot up in little more than a matter of seconds.

That typifies the speed of combat. Pilots who were in the Battle of Britain said that the Malta show was fought at a quicker pace. The target was small, the vital area being at most five miles by three, and often much less than that when attacks were concentrated on the harbour. So thick was the traffic that air collision was a constant danger. As for the aerodromes, they were so pockmarked with craters that a fighter taking off had to pick its way and could never be sure of finding comfortable space to land. Ground staffs slept in snatches. When not servicing they were filling up craters; and both jobs had to be done under constant pounding from the air.

Two American pilot officers, one from Norwich, Conn., and the other from Berkeley, Calif., once had the luck to meet the enemy on equal terms. While on patrol they saw two Messerschmitts several thousand feet below them. The Californian took the one on the right. Swooping down, he let go with all he had, both cannon and machine gun ammunition. There was a white flash—the Messerschmitt hurtled seawards. The Con-

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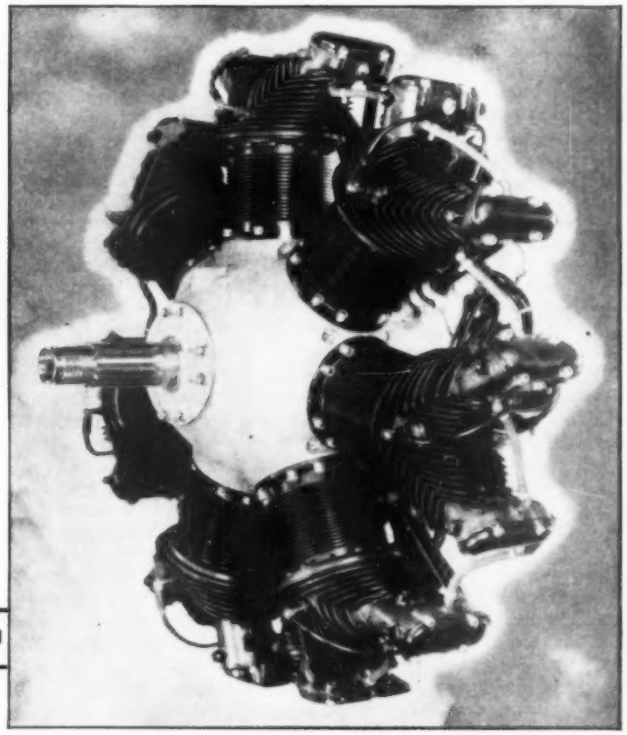

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necticut Yankee had already given his prey a sharp burst. Now, having lost it in cloud, he used his last rounds to make sure of the other. But coming out into the clear, he saw his own private victim 2,000 feet above the water, plunging blindly after its fellow. Sixty seconds work. Over the radio telephone, in best Quentin Reynolds manner, came a laconic growl: "Okay. Let's go home."

Sixty seconds work, and two more added to the bag—which totalled 567 by the end of May. April gave the highest score. Enemy losses for that month, excluding probables, were:

Bombers 68; dive-bombers 29; fighters 29; one seaplane; and 11 planes of unspecified type. Of this total of 138, fighters accounted for 32 and the antiaircraft defences for 91; in 15 cases the method of destruction was uncertain. In May, 93 Axis aircraft were destroyed; the attack was slackening.

Only the historians will be able to assess what Malta cost the Axis in shipping. Even during the five months continuous air attack, and with as many as 300 Stukas in action against them on a single day, Malta's naval units and bombers relentlessly sank or damaged enemy ships, either in passage or in port. On one occasion a naval torpedo-bomber sank a 12,000-ton liner filled with German troops and equipment. On another night three out of four fully-laden ships (one carrying tanks and motor transport) were sunk in Palermo harbour by British Vickers *Wellingtons*. These successful attacks were merely two of many; and there is no space to tell here the story of how the Allied convoys fought their way through the narrows; or how a whole flotilla of Italian E-boats was shot to pieces attempting to raid Valetta.

In peacetime the Grand Harbour sheltered the shipping of the world. Standing on the Baracca, facing the great sandstone bastions where houses by the thousand perch precariously on the rock, and looking down on the port and the naval dockyard with the French Creeks running off it, you would see the flags of a dozen nations. Among the tangle of shipping were the warships, painted light Mediterranean grey, white awnings covering their fo'c'sles. Round them dghaisamen yelled warnings as they jockeyed their picturesque ferryboats into position. Near the Customs House steps carrozzimen waited for fares. The pleasant tumult of the scene contrasted with the peace of deep blue water.

Now the gaiety is gone. Bombing has left deep gashes. The warships are camouflaged and dingy after many hours at sea. Some show scars of battle; the shipping they have perilously convoyed is in little better case. But the dghaisamen are still alongside and the carrozzimen wait at the steps. War or no war, the Maltese ply their trades.

But for their bravery, the defence of Malta would have been a far harder task. They number 250,000. Agriculture is their mainstay; fields terrace the hillsides; the shallow layer of soil which covers the limestone substrata of the island has always been industriously tilled. During the worst raids the men still trudge behind the oxen which draw their crude wooden ploughs.

They feel not only hatred but contempt for the raiders. At the gate of the Baracca there stood in peace and war a pedlar of sweetmeats. Though well in the target area, he scorned to take cover. He cheered each fighter victory, he threw his cap in the air when a convoy got through. One day a direct hit got him; his cap was all they found.

Nearby, the Maltese man the famous Royal Malta artillery. Magnificent marksmen, they also display amazing courage. With bombs crashing all round them they strive to maintain their rate of fire—at its peak, 2,000 bursting shells a minute, the finest antiaircraft barrage in the world.

So far the Army have not had to repel invaders, but as rescue squads and working parties they have proved superb. They show notable toughness. Every soldier does a four mile cross-country run twice weekly, raid or no raid. All the officers take part, even the Headquarters staff.

A splendid comradeship links soldiers and civilians. Together they have endured the heaviest and most sustained air attack in history. That is their common pride.

So life goes on. Spring comes. Daffodils and irises brighten the flower baskets in Kingsway, Valetta's "main street." Now it is high summer. Still the Luftwaffe are baffled, still life goes on.

Two newspapers come out daily; schoolchildren sit for their examinations; Gozo fishermen cast their nets; farmers reap the crops, barbers the beards of their customers.

The sirens still wail at intervals. The children in the streets sing: "They'll be wearing big iron crosses when they come." The author of that song is anonymous. Perhaps he was one of the American pilots—California, Florida, Idaho and New York are all represented. Anyway, it's a very good song.

Malta is steeped in tradition; everywhere you are reminded of past glories. Occupied in turn by Carthaginians, Romans, Arabs, Normans, Knights of St. John, French and British the island has a story which recedes beyond contemplation to the Paleolithic ages, when Malta was part of a land bridge linking Africa to Europe. But there is no land bridge now; and as for the air bridge, a united people have sworn that the Nazis shall never cross it. That goes for any invader. The old woman who was heard to say, as she crossed herself devoutly while the Luftwaffe's bombs rained down: "Please God send the Italians!" had only one ground for her petition—her preference for the marksmanship of the Regia Aeronautica.

Outside the Palace Square of Valetta is an inscription in which the secret of the heroic resistance stands revealed: "To Great Britain, still unsubdued these islands are entrusted by the Powers of Europe at the wish of the Maltese themselves."

END

Air Power in War

(*Continued from page* 40)

all to see. In a battle between two otherwise equal opponents, it is the side with air superiority that will win. This is as true for land and sea battles as it is for purely aerial ones. Finally, air superiority plays an essential part in the destruction of the enemy's will to make war, which is the final aim of our strategy. The achievement of general air superiority over the enemy must therefore be one of our cardinal aims.

Although our strength is rising constantly and numerical parity with the enemy has been achieved, we have by no means met all our requirements and it can safely be said that we shall never do so. New demands are always arising, and will continue to arise, more quickly than we can meet them.

The entry of Japan into the war created vast new requirements in India and the Far East; the increasing threat to our positions in the Middle East compelled us to increase our forces there considerably; the intensification of the U-boat war against our shipping has meant that an increasingly large proportion of our resources has had to be devoted to reconnaissance and to the hunting down of submarines. As the range of our aircraft increases the area of sea which they can patrol increases still more, so that it is necessary to employ a far larger number of aircraft to cover it completely. Moreover, experience of this war has shown that Naval forces can rarely operate in narrow seas within the range of powerful shore-based air striking forces, so that more and more of the work previously done by the Navy is now being taken over by the RAF. In this sense more and more seas are becoming "narrow seas"; the Mediterranean as a whole is rapidly coming into this category.

Another need created by the present war has been for long range aircraft for transport purposes. Here the enemy had the advantage of a large stock of obsolete bombers and these he used with great effect to transport supplies and men. Because we rearmed later than the enemy we had no such stock of obsolescent aircraft available; we have had to make do with an inadequate number of transports supplemented where necessary by operational aircraft diverted from their proper role. It will be a long time before we have all the transport aircraft that we need.

The development of air-borne forces has meant that much work has also now to be done in adapting aircraft for the release of parachutists and for the towing of gliders. The building of gliders and the training of their pilots detract from the resources which would otherwise be available for operating powered aircraft.

It is our constant endeavour to increase the adaptability of the basic types of aircraft to enable them to undertake efficiently the many calls that are now made. A heavy bomber can be used as a heavy transport and communications aircraft, as a long distance aircraft for sea recon-

(*Continued on page* 236)

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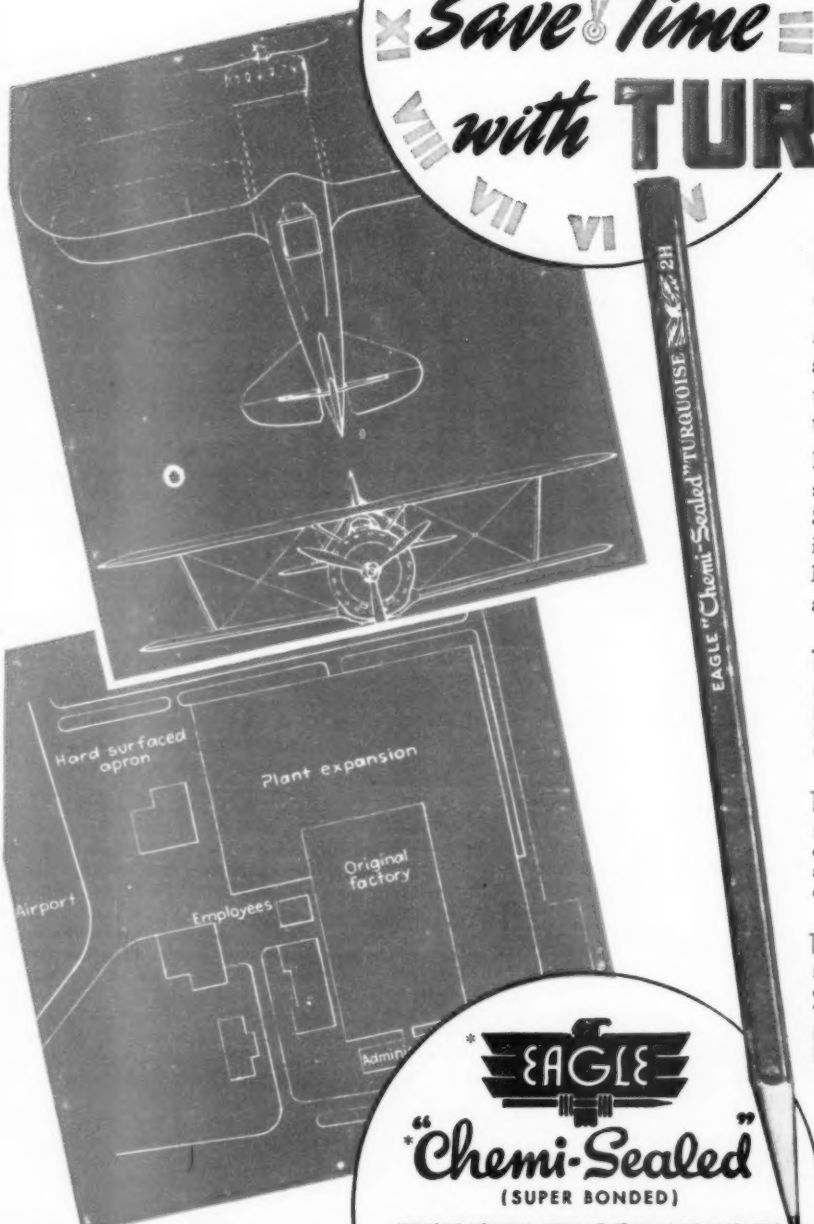

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(*Continued from page* 234)

naissance, as a mine-layer, as an ambulance, etc. What is basically a fighter can be used also for high altitude reconnaissance, tactical reconnaissance with the Army, low level bombing and cannon fire attacks on ships and land targets. The very adaptability of aircraft means that the demand for them must go on increasing and that we can never have all that we need.

The RAF has been fortunate in having behind it great productive resources. The British aircraft industry had been growing fast before the war and has made great strides since, until it has become directly or indirectly the greatest single employer of labour in the whole country. For a long time it had to give particular attention to the production of modern fighters, which alone could secure our base against enemy air attack. Thanks to the makers of *Hurricanes* and *Spitfires* the RAF was able to achieve a decisive victory in the Battle of Britain in 1940. Fighters are still required in very large numbers, but it is now possible to give greater attention to the production of heavy bombers, and large numbers of four-engined heavy bombers are being produced every month.

The RAF could never have become what it is today without American assistance on a large scale. For some time Lockheed *Hudson* medium bombers have been providing much of the reconnaissance over the sea carried out by Coastal Command. American Curtiss fighters and Douglas and Glenn Martin bombers have played an essential part in air operations in the Middle East. The reinforcement of the RAF with these and other types of aircraft was already taking place on a large scale before America entered the war. With the enormously increased scale of production that has become possible now that she is in, and with the aid of the American crews and ground personnel now taking their place in the fight beside those drawn from all parts of the world who have hitherto manned the air units of the United Nations, we can hope to build up combined forces far greater than those which the RAF could have dreamed of achieving alone.

The demands for air forces for defensive purposes are numerous and compelling; as I have explained many of these are essential and have to be met. Nevertheless, one of the soundest rules in war is to allot the minimum for defence in order to keep the maximum for attack. It should soon be possible to say that the minimum necessary for defence has been provided and we can then concentrate our efforts on building up the mighty striking force which alone can pave the way to victory.

The large scale bomber offensive against Germany has been in all our minds since the beginning of the war. Until recently our bomber force has been a comparatively small one. Even so, it has been able to deal many heavy blows at ports and centres of German industry and communications. It has also been largely instrumental in compelling the Germans to maintain in the West a considerable force of long range bombers and well over one third of their fighter force at a time when she could ill spare them from the Eastern front. It has thus made an important contribution to maintaining the strategical position of the United Nations. However, what they have achieved is as nothing compared with what they are now beginning to achieve and what, with the help of the American bomber force destined for this country, they soon will achieve.

Now that the RAF is beginning to build up a large force of bombers capable of carrying a really heavy load, it is possible to develop a new technique of delivering highly concentrated and destructive raids on vital enemy targets. The results so far have been most successful. The first was the raid on the Renault Works outside Paris on the night of March 3. This great works was turning out tanks and mechanical transport for the Germans on a very large scale. In the course of one night's raid it was put totally out of action. One of the photographs taken after the attack is reproduced elsewhere in this issue and readers will be able to see for themselves what was accomplished. This raid was followed soon afterwards by an equally successful attack on the port of Lubeck, and then by raids on four successive nights on the town of Rostock, where an important Heinkel aircraft factory is located. You can see for yourselves the damage inflicted on the factory in the photographs illustrating "Bomber Command." These raids were a foretaste of still larger raids to come.

On May 31, over 1,000 aircraft were despatched to attack the town of Cologne, and two nights later a similar number attacked the Ruhr. These raids set a new standard for large-scale concentrated bombing. The results justified all our expectations. At the expense of relatively small losses of aircraft the defences of the areas attacked were completely overwhelmed and an enormous amount of destruction was caused. Cologne in particular suffered badly and large areas of the city are devastated.

These enormous raids have brought home to the people of Germany, perhaps for the first time, their vulnerability to air attack. The effects must have extended far beyond the immediate neighbourhood of the Rhineland. No town in western Germany can now consider itself safe and as the nights lengthen the area which our bombers can cover in darkness extends. Soon it will be possible once again to reach Berlin and other cities in the eastern half of the Reich.

Let it not be imagined that the effects of this bombing are confined to the civil population and that the military results are small and remote. Our bombs are attacking the factories and workshops which are constructing tanks, lorries, aircraft and submarines upon which the enemy's striking power is founded. They are thus assisting in the common struggle against the enemy in the same way as if they were being dropped on tanks in the field or on submarines at sea. They are doing more than this; they are striking at the German nation and at the roots of its will and power to make war. They are taking the war into enemy territory in a way that has not occurred since the Napoleonic wars. They are destroying the legend, so successfully built up by Hitler and his fellow Nazis, that Germany was secure and unassailable and that war could take place only in other countries. The Russians in the east and the RAF in the west are already preparing in Germany a state of demoralization.

The time is not very far off when the British and American bomber squadrons in England will be able to destroy the industry and power of Germany at a rate which outstrips repair. When that time comes, will the average German long resist the conclusion that the war is no longer profitable and the Fuehrer no longer worth following?

END

Engine Production

(*Continued from page* 163)

There is, in the first place, a very close liaison between these firms and the airframe (or aeroplane) builders. The normal practice is for an aeroplane designer to visualise forward requirements and put a design for a new aeroplane on paper which in turn will call for an engine of a certain power. He will approach the aero engine builder and ask what he has to offer. Maybe he has nothing to offer at the moment but will have something ready by the time the first machine is on the stocks. This may be an entirely new engine or it may be an improved model of an existing type. In peacetime, such a combination of the aeroplane and the engine might be put forward to the Air Ministry as a private venture, or it might have been built to satisfy a definite specification. Time, then, was not necessarily important and the prototype machine would be built in due course and tested. If it was promising, a few more would be built for use in RAF squadrons so that experience could be gained before a production order was given. From the time the project was first considered, to the time when the machine was in full production, might be anything up to four or five years. And, as is usually the case with engines and aircraft, it would probably be obsolescent; new marks of the same engine would already be appearing (at least experimentally) to replace it.

In war, of course, time is very precious and as soon as the air staff indicate their wish for an aircraft of some particular type the design staffs of the firms concerned get busy and offer something, *on paper*, in a relatively few months. The "prospectus" for a new machine will come out fairly quickly, based on the aggregate knowledge of the aeroplane and engine builders but, of course, it takes many months to do the detailing of a new aeroplane.

However, the needs of war are such that an aeroplane is now ordered "off the drawing board" and jigging and tooling begins soon after its design is approved.

The speed at which this machine, as a whole, will be produced and flying de-

(*Continued on page* 240)

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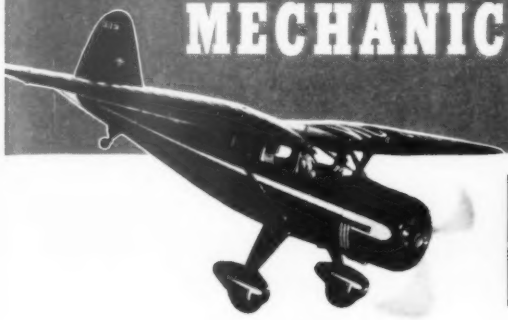

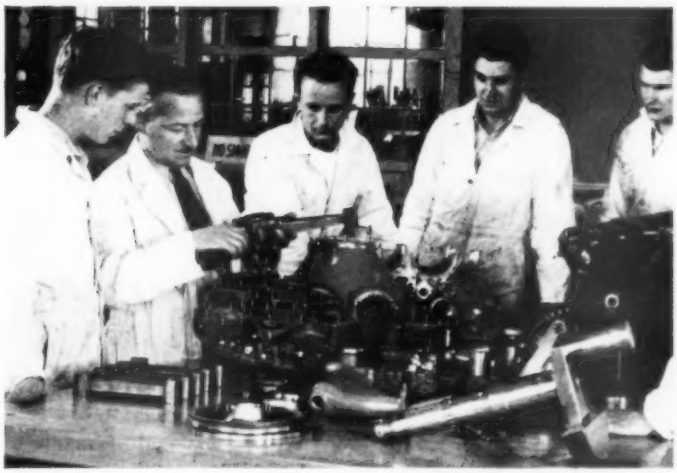

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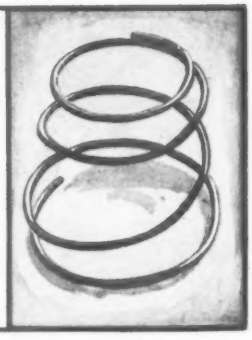

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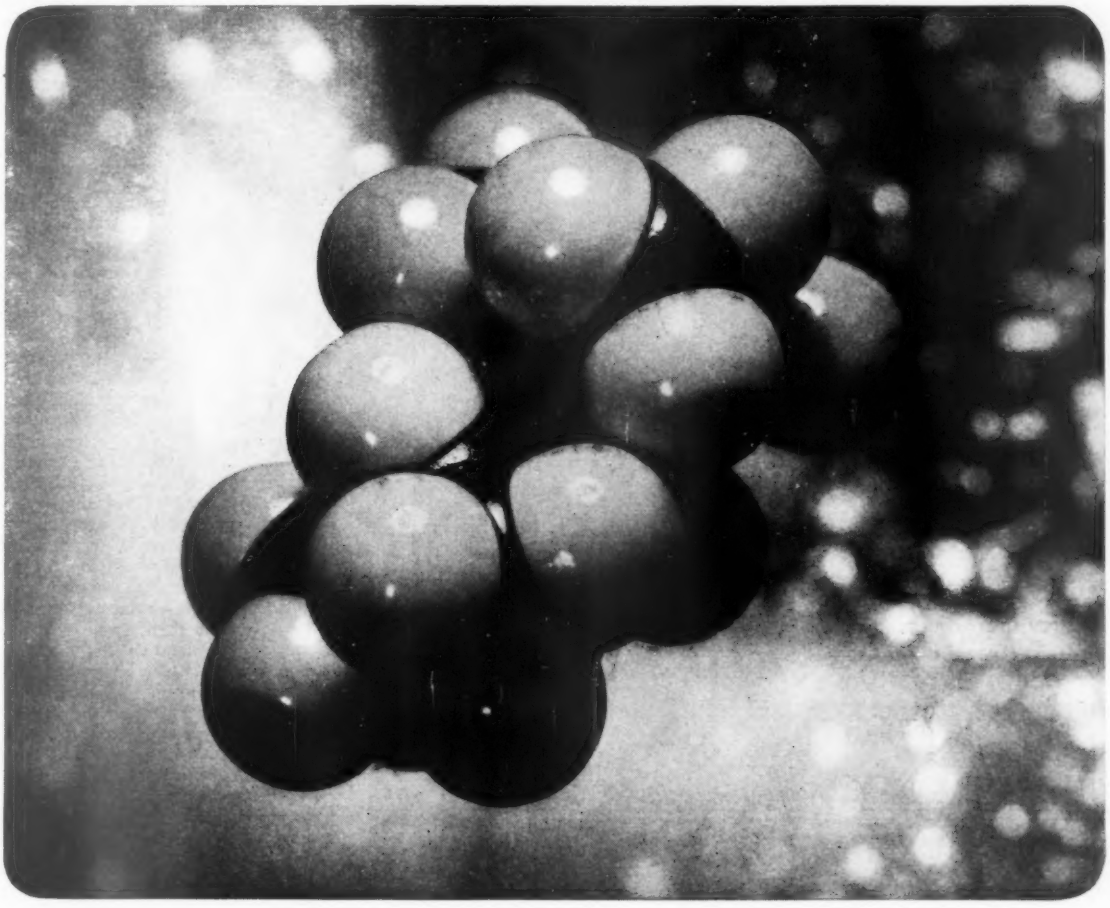

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(*Continued from page* 236)

pends upon the success of its initial design and also upon whether the engine is of entirely new design or is an improved "mark" of an existing type. Before the war, when speeds ranged around 200 m.p.h. and when the biplane was favoured by the RAF, it was not difficult to evolve a new type of machine. But the change to the monoplane and the demand for speeds around 300 m.p.h. brought a whole train of trouble—wing flutter for example—which had not previously been apparent. Now we speak quite casually of speeds of 400 m.p.h.; and the difficulties of the aeroplane designer are further increased. Two years will probably elapse from the initial design stage to the completion of the prototype aeroplane.

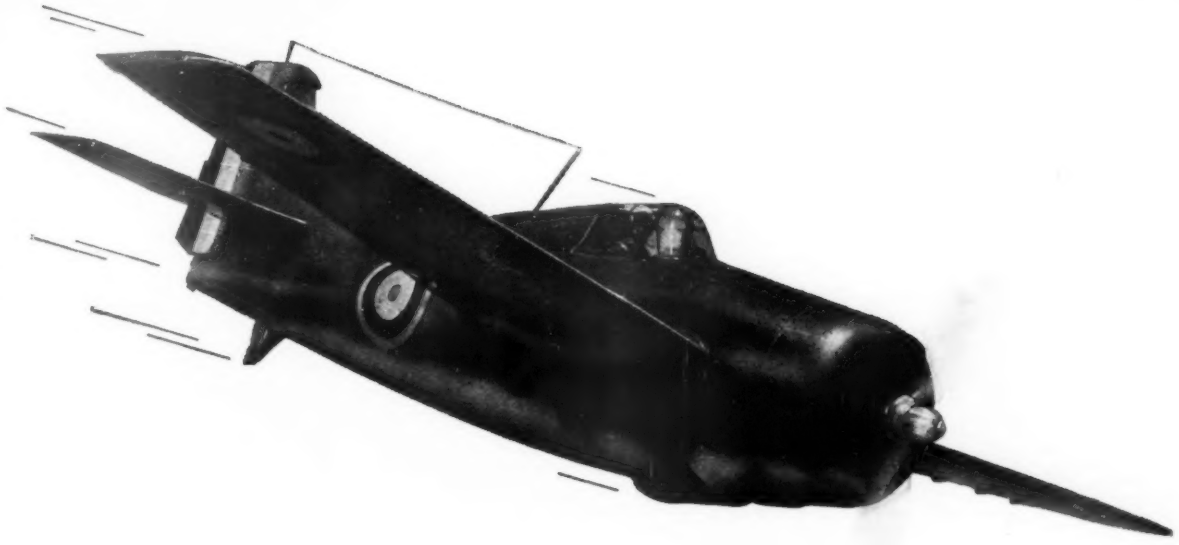
The production of the engine, however, is quite another matter since it takes about four or five years to get a new type engine into production from the drawing board. This period will vary according to the ability of the development department or the engine firm in question, but it has never been much less than four years. The experimental engines are produced in, say, 18 months or two years and, if reasonably satisfactory, are given a special category test in order to enable them to be put into the prototype aeroplane so that flight testing can proceed. In the meantime the development of the engine on the test bed is being pushed hard and the jigging and tooling for its production is going ahead. It is, of course, known what machine tools will be required, in numbers and type; but, inevitably, the jigging and tooling may have to be altered according to the degree of trouble met during bench and flight testing and the consequent amount of re-design which becomes necessary. So, eventually, a complete aeroplane is evolved during war time. But a good deal of frantic work, both on the part of the aeroplane and engine builder, is necessary to produce it.

Naturally, if only an improved version of an existing engine type is required, then a certain amount of time is saved.

While, therefore, in peacetime, an engine was in a reasonable state of development before its production commenced, in war time, we have to face a good deal of teething trouble while the engine is already being flown and, in fact, has been fitted in relatively large numbers in aircraft actually engaged on war operations.

Where, in the past, engines have been produced only by the parent firms, it was a relatively easy matter for the parent company to produce and keep step, during production, with any alterations which may have become necessary as the result of further development. But now engines have to be produced by firms which have not previously had aero engine experience, such as the "Shadows."

The "shadow" engine industry in this country has undoubtedly done a fine job of work and the co-operation between the parent firms and their "shadows" has been, and is, excellent. It is, of course, difficult to introduce a modification to an



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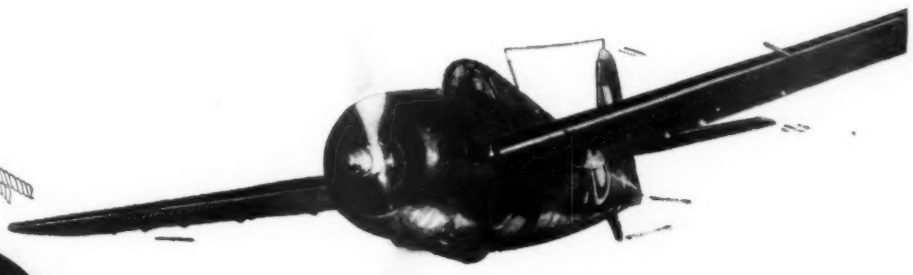

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engine when it is in large scale production by such firms. And every care is taken to see that a modification is absolutely necessary before it is approved and incorporated.

The aero engine industry before the war, in the days of retrenchment, was not large enough to support the demands with which it is now faced for skilled workmen. Indeed there is a general shortage throughout the United Kingdom of skilled machinists and fitters; consequently, large training schemes have been initiated.

Men and women from all walks of life are now in our factories, operating machines and assisting in the assembling and testing of aero engines—insurance agents, shop assistants, milliners, manicurists, clerks, actors, actresses, musicians, and so on. These men and women have shown remarkable keenness in their new work and many have demonstrated real ability.

One of our "headaches" (particularly acute in 1940 and 1941) has been the difficulty in finding managerial staff.

In the heavy bombing period, after the fall of France and during the Battle of Britain, it was necessary to disperse some of the larger factories. It is not generally realized how difficult this was because it meant multiplying supervisory staff and often housing workmen in rural areas hardly capable of accommodating more than a few thousand of their own inhabitants. Yet it has been done with only a temporary drop in production which overall has contained steadily to increase.

There are many marks of aero engines in production in Britain today. Indeed one of the problems of the directorate general of engine production is the rapid improvement in engine types. There may be six new types in production now; there will be as many further improved types to produce 12 months hence. If an engine is outstandingly successful, the Air Staff will wish to get as many into operation as quickly as possible. A hundred fighters, modified to take a new engine, may be demanded for delivery within a matter of a few months. This raises at once a multitude of difficulties. The airframes themselves have to be modified. The installation and equipment may have to be changed. The capacity required for, say, new radiators must be doubled and so on. The question of spares also arises. Aircraft, whether in the front line or in reserve and according to type, need, in addition to their basic quota of from one to four engines, a certain number of spare engines. All these spare engines require spare parts, which must be despatched and held in store for maintenance wherever the engine is to be used. The demand for spare parts is enormous and absorbs a large part of the productive capacity required for the manufacture of the complete engine.

This, coupled with the "production cycle," the time taken to obtain materials, plan production, fabricate and assemble the component parts of an aero engine, stretches the resources of the engine industry severely.

Emergencies arise and must be dealt with swiftly. Last year, during the "blitzing" of Britain, the necessity for flame damping the exhausts became apparent. This entailed a new design of exhaust system which, when finalised, had to be fitted with all possible speed. Working parties had to toil night and day to fit these system so that the night fighters could get within firing range of the bombers, undetected.

Finally, a word about the actual engines. The two most famous British makers of engines whose products had a world wide reputation even before the war have more than justified this reputation—Rolls-Royce and Bristol. Their engines have made history.

The Rolls-Royce *Merlin* is a liquid-cooled, 12 cylinder V engine which started its life by giving 900 h.p. at what is now regarded as a very low altitude. Today, it has a 50 per cent better all around performance and has been developed to maintain it at extremely high altitudes.

The Bristol Company, famous for their air-cooled *Pegasus* and *Mercury* poppet valve engines, which are still giving valuable service in a number of important operational aircraft, started producing their new 14-cylinder sleeve valve air-cooled engine, the *Hercules*, before the war. It is now in full production and gives more than 1,500 h.p.

The Napier Company have also developed, and are building, a liquid-cooled sleeve valve 24 cylinder H engine, known as the *Sabre*. This engine has yet to win its spurs in war, but it can be stated that it is the most compact engine yet built, in any country, for an output of over 2,000 h.p.

END

Works Directorate

(*Continued from page* 106)

bombers were concentrated over enemy territory that prior to the vast organisation which made the raid possible there first came into being that basic essential —a huge acreage of level ground. The Aerodrome Board first selected it. In the days when the present war was still only a vague possibility, it was clear that in airfield space Germany possessed a considerable advantage, though this might be offset to some extent by the plains of France. A policy of self-sufficiency was laid down and gradually implemented.

Every corner of these islands was surveyed from the airfield point of view, and when after less than a year of war Britain stood alone, the wisdom of that prior planning became obvious. Every square yard of airfield surface was precious, and a great increase of acreage was urgently needed. But crops were needed too; never in our history were harvests so important. By careful planning the airfield space was found without diminishing the food producing areas unduly. Today, however, with Great Britain acting as a huge advance air base for the growing strength of the U. S. Army Air Force, the aerodrome problem is increasingly difficult to solve.

The Aerodrome Board submits a report in which a reasoned estimate of the possibilties of each site is given. This goes to the Director of Planning, who consults with the Director General of Organisation and the chiefs of the RAF Commands. At the same time the Works Directorate is examining the problem, so that in the next stage the operational requirements of the Air Force can be balanced against technical difficulties. The final decision is thus based on consideration from every angle, but this does not mean that the process of selection is slow. In peacetime, no doubt, it tended to be leisurely; in time of war it is rapid. From the moment when the trawler's boat put the first surveyor ashore to the turning of the first spadeful of peat on the northern island may have been a month; it would certainly be little more. And a month is not long to decide how half a million pounds shall be expended.

Once the decision is made, Works Directorate takes over. They are responsible for providing the aerodrome complete with all essential services. They purchase or hire the land, design the lay-out, and go straight ahead. Runways and roadways, piers and slipways, water and electricity, drainage and sewage; cooking, heating and ventilating; petrol and oil storage, workshop machinery and wireless masts—these needs indicate the range of activities which the department covers. Sometimes an entire railway system is necessary; and on more than one occasion complete harbour installations have had to be provided before the airfield construction could start.

Camouflage is clearly an important part of aerodrome design, but many misconceptions exist concerning its basic nature. Before the war Royal Commission on Fine Arts was frequently consulted by Works Directorate when any new scheme was under consideration. The purpose of this liaison was largely to avoid complaint from local residents that aerodrome construction was destroying amenities of architecture or scenery. Nevertheless, it was also known that while skillful painting, netting and similar devices are useful aids to camouflage, the first essential is that the structure to be hidden shall blend in broad outline with the landscape. Such qualities in his subject make much easier the camouflage artist's task. While protecting the RAF from the charge of vandalism, so frequently levelled against Government building in time of peace, the Royal Commission had made a valuable contribution to our wartime security. It was never expected that complete concealment of the average aerodrome could be effected, but in developing the theory of camouflage artists and scientists have joined forces with considerable success. Even in the desert, where nature affords little assistance, their triumphs have been notable.

Difficulty of camouflage is by no means the only problem of work in the desert. If work on the peat-bog was complicated by the presence of water, there have been many occasions when its absence presented equal danger. To picture the

(*Continued on page* 252)

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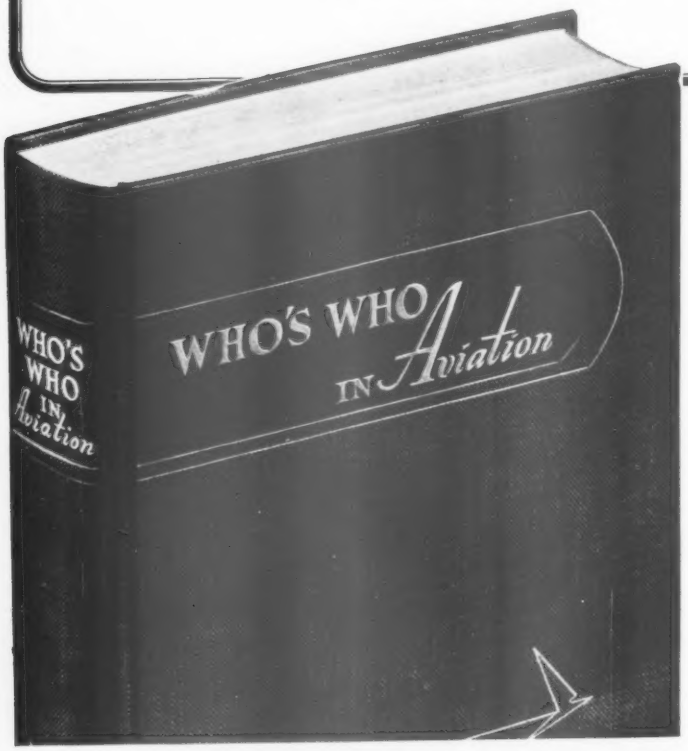

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For Aircraft Pipes & Tubes

(*Continued from page 242*)

desert as a huge natural airfield is a very natural error. While it certainly offers maximum chance of safety in forced landings, a loose sandy surface can give rise to appalling difficulties in take-off. Of the devices by which these are combated little can be said; but those who have seen how often our aircraft are in evidence over the desert at times when the enemy force, of presumably comparable strength, is not, have probably drawn correct conclusions. The achievements of Works Directorate in the desert were based on experience in mandated territory. In this we have the advantage. Fairness demands that we acknowledge the fact. Extensive experience of sand as a substance highly inimical to the operation of aircraft we now share pretty equally with our opponents. But we did have a fairly long start.

Most of the tasks which the Works Directorate performs are based on experience; their details have been worked out by trial and error; so well are their outlines known that a few brief directions can sometimes set the while machinery in motion. On the other hand there have been occasions when improvisation has been necessary, when aerodromes have had to be constructed against the clock from whatever material was to hand.

The advance parties who landed in Norway to prepare for the air defense of that country against the ruthless German advance faced heart-breaking problems. The few Norwegian airfields had been seized by the invaders. If our planes were to operate it was necessary to make use of whatever level surfaces could be found. They were few in number, and with the snows just melting, extraordinary difficulties were encountered in their use. Neverthless our planes took the air. One squadron operated from a frozen lake, with the German bombers raining down high explosive on the ice.

At another point a level stretch was found but a ploughed strip ran at right angles across the run. Three hundred thousand turves were cut from surrounding fields and fitted into the furrows. Then, to improve the surface, every scrap of wire netting in the district—rabbit wire, fencing, anything that could be found, was laid along the track. Still it was too soft for a takeoff. But the RAF officer in charge would not throw in his hand. The entire wooden fencing of a sports field was pulled up and laid along the run. When it proved too short, hundreds of snow-shields were collected from miles around. At this point German air reconnaissance spotted the work and soon the machine-gun bullets were whistling down. With brief intervals under cover, the workers went on. The same evening our fighters were in the air.

The story of that airfield made from nothing under enemy fire (there was sniping from fifth columnists to contend with as well as bombs) is as fine a tribute to the spirit of "Works and Bricks," as the department is affectionately called, as any praise for their more elaborate achievements, some of which rank as engineering feats of high order. The story sums up the spirit of the men. Whether in the snows or in the desert; whether up to their waists in a peat-bog or tunneling deep into a mountainside; bombed, sniped, or machine-gunned, they have only one creed. It is a creed shared by the whole of the English-speaking world: *the job must be done.*

END

Organisation of RAF

(*Continued from page 42*)

geographical basis. Bomber Command consists of the main force of bomber aircraft, and Fighter Command consists of the main force of fighter aircraft. Coastal Command and Army Co-operation Command I have already mentioned. In addition there are the vitally important Maintenance Command, the two Training Commands (Flying Training and Technical Training Commands), Balloon Command and Ferry Command. Maintenance Command is one of the largest in the entire Air Force. It has been described as "the wholesaler and retailer for the operational commands." It receives the aircraft, and what is almost more important, the more than 750,000 separate parts of aircraft and items of stores, which the RAF needs. It holds them in gigantic depots and distributes them when they are wanted. The Training Commands are also, as you can imagine, vast organisations, the function of which is to provide a never-ceasing and ever-broadening flow of pilots, air gunners, navigators, bomb aimers, wireless operators, skilled fitters and riggers and men of many other trades to the RAF. Balloon Command operates the extensive balloon barrage which protects all our principal cities from low-level attack. Ferry Command is responsible for the delivery of American aircraft across the Atlantic.

The symmetry of this system of functional commands has had, however, to be modified by the fact that the RAF must operate in many different parts of the world remote from these islands. Therefore three separate commands, those of the Middle East, India and West Africa are organised on a geographical basis. Each of these commands operates both bomber and fighter and other types of aircraft. The Middle East Command is already a very formidable force on its own, bigger than the entire RAF at the beginning of the war. These commands have problems of their own of great complexity. You can easily imagine what it must be to maintain and operate aircraft from those distant bases, in countries which lack almost all productive industry. Almost every item of stores has to be brought to them after long and perilous sea or air passage.

The next unit below the command is the group. Most commands are organised in a number of groups which are generally disposed geographically. All the bomber stations in a particular part of the country, for example, are organised in a group. They are generally commanded by an air vice-marshal. The group may contain either a number of stations or a number of wings. A typical station in Bomber Command for instance consists of a main aerodrome and generally one satellite aerodrome under the command of a group captain. There may be two or three squadrons operating under the station commander.

Some half a dozen or more of these stations are contained in each group. If the stations were built before the war they have first rate buildings—messes for the aircrews, barracks for the airmen, recreation rooms and the like. If they have been built since the war their occupants have naturally to make do with something much simpler and great regard is paid to dispersal and concealment.

Where squadrons operate individually and moves are frequent as, for example, with an Army in the field, it is found more convenient to adopt the organisation of a separate wing headquarters controlling a number of squadrons on separate landing fields.

It is, however, in the squadron that we find the real basic unit of the RAF. The squadron consists of a little more or a little less than a score of aircraft, according to type. This is the unit, analogous perhaps to the battalion or battery in the Army, or the ship in the Navy, around which the loyalties and the healthy rivalries of the aircrews centre. It is in the squadrons, moreover, that there arises that immense scope for leadership, that need of the power to inspire and to weld men together, upon which so much depends in any armed force. Operational squadrons have their ups and downs; they are sometimes shattered by grievous losses but are rallied by successful leaders or they lose trusted commanders who have to be replaced by new men. These squadron leaders are for the most part very young; in their early 20's in many cases, and on them falls tremendous responsibility. They have not only to lead their pilots and aircrews in flight and combat, but also to command their 200 or 300 men of the aircraft maintenance and ground staffs. On the tireless and often very heavy work of these mechanics depends the whole efficiency of the squadron. A squadron may have 20 splendid aircraft, but if its "serviceability" as it is called, is low, only a small proportion will be able to take the air. It is only by developing the most highly skilled and self-sacrificing mechanics directed by highly effective non-commissioned officers that an Air Force can keep going.

Here then, in the very broadest outline, is an account of the organisation of the RAF. You will realise that this now vast and mighty force is incomparably more complex than I have been able to suggest in this article. But it is perhaps best that you should be given the broadest possible picture in order that you may grasp the salient points. Finally, let me repeat that we are under no illusion that the organisation of the RAF is perfect. We do not suppose that we have solved every problem. New and extremely exacting tasks are constantly facing the RAF. We are constantly endeavouring to learn from experience; to adopt

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what have proved effective practices from our allies—and even, if need be, from our enemies! Nevertheless we firmly believe that the present basis of the RAF as a centralised organisation is indispensable to the existence of Great Britain as an independent nation. Two years ago that force stood between the British people and certain enslavement to the Nazis. Now the RAF is ceaselessly attacking, heavily engaged with formidable enemies on a dozen fronts. Its fighters range the coasts of occupied France; its bombers pound the cities of Germany; in the Middle East it has made Malta a graveyard of German and Italian aircraft. It has not escaped without suffering heavy losses. It has further ordeals before it, but now it has been joined by powerful allies. The Soviet Air Force and the United States Army Air Force and Naval Air Service are gathering in the east and in the west. The men of the RAF, and the women of the WAAF will go forward to victory in company with the airmen and airwomen of the United Nations.

END

WAAF

(*Continued from page* 129)

into a trade was no longer dependent on a woman's occupation or capabilities in civil life.

Then came the Battle of Britain, when the Luftwaffe, made every effort, but without success, to undermine the morale of civilian population and Service personnel alike. During the daylight mass bombing attacks on some of the Fighter aerodromes in August and September, 1940, the WAAF plotters were to be seen in the operations rooms with their earphones pressed to their ears to keep out the inferno of noise from the torrents of bombs that were bursting all around. Steady and calm at their posts, these airwomen never faltered in their duties. There is the story of the operations room that received a direct hit and of the WAAF telephone operator who stuck to her post, vainly endeavouring to keep communications going until at last the heat and suffocating smoke of the fire forced her to give up; of the airwomen's trench that was bombed and of the cheerful courage of the wounded as they were dug out and placed on stretchers; of the WAAF sergeant who calmly went out into the aerodrome and began to peg out with red flags all the places where unexploded bombs were buried as a warning to the returning fighters. And there is the story of the WAAF cooks who managed, to their eternal credit, to turn out good meals at all times of the day and night in the face of such difficulties as lack of water, light and sufficient sleep.

Hundreds of other stories could be told of these airwomen, their undaunted courage, their calm devotion to duty.

And here is the story of a WAAF corporal, now commissioned. She rescued a pilot from the flaming wreckage of a crashed aircraft with its bomb-load still aboard. As she dragged him from the danger zone the bombs started exploding and she shielded his body with her own. Her bravery earned her the Empire Gallantry Medal—now called the George Cross—"for meritorious acts of gallantry." Other awards to members of the WAAF include the Military Medal, the C.B.E., the N.B.N. and the B.E.M., for as the WAAF share the dangers with the RAF, so they share the honours. Although they do not fly as aircrews, the Defence (Women's Forces) Regulations, 1941, declared the WAAF to be members of the Armed Forces of the Crown. This is a tribute to the proven value of the WAAF in this fight for freedom which has involved the whole of civilization and brought women to their ranks from all over the world.

When in 1940, thanks to the fighter pilots of the RAF, the Luftwaffe had been driven from Britain's daylight skies, life largely resumed the normal working routine of a nation at war. Now the WAAF had won their spurs they were wholeheartedly accepted as part and parcel of Britain's flying service. The RAF were proud of the WAAF. Still more trades were opened up for the airwomen. Substitution of WAAF for RAF personnel continued to take place on an ever-growing scale.

For certain work complete substitution of WAAF personnel for RAF, instead of a percentage substitution, is now visualised. Some of the barrage balloon sites, for instance, already are manned entirely by women.

A large proportion of the WAAF is occupied in cooking and catering for the RAF, cleaning its quarters, manning its telephones and teleprinters, staffing its multifarious offices, and dealing rapidly, patiently and accurately with the myriad humbler routine tasks which together ensure the successful administration of a great Service. The WAAF had now become a highly organized service fulfilling its main object of replacing officers and men of the RAF employed on ground staff duties. A number of WAAF code and cypher officers have been serving for some time in the Middle East.

Although so far airwomen have not served in the capacity of aircrews, WAAF officers have for a long time flown on duty. Now airwomen too are permitted to fly on duty. No longer will women flight mechanics be earthbound on the tarmac watching with obviously eager eyes the aircraft they have been working on soar into the skies. They, too, will be airborne with the craft on testing flights, seeing tangible results of their work in operation. Another type of flying duty is that of the nursing orderlies, who are specially trained for duties in air ambulances.

Just as the WAAF has a trade for almost every type of woman, ranging from tasks of a purely domestic nature to office, secretarial and scientific work so the recreational and social side of service life is generously provided for. Energetic sport is available for the "outdoor girl." Recreational facilities are many and varied and airwomen can work off surplus energy in games, swimming and dancing; or they can relax in pleasant rest rooms and canteens when off duty. Opportunities are afforded for pursuing educational studies interrupted by the war. Foreign languages can be learned, or typing and shorthand be speeded up by attending "night schools" after duty. Health is carefully guarded, and besides having the benefit of the ordinary medical services provided for the RAF generally, the larger WAAF centres have qualified women doctors of the RAF medical branch.

After nearly three years of action, the WAAF has found its "place in the sun" working in co-operation with the RAF for victory. Their reward for taking on more and still more work is in seeing an increase in the numbers of trained flying crews, many of whom would otherwise have to be retained on ground duties. They have the additional satisfaction of knowing that they have played an important part in servicing the aircraft in which these crews are flying.

In this great substitution of women for men, the RAF has demanded as much of the WAAF as they have of themselves. But the WAAF are determined that, come what may, whatever the duty or wherever the battle, they will face it successfully, together with the RAF.

END

Army Cooperation

(*Continued from page* 77)

area by such and such a time. In these circumstances their machinery of ground-air operation was excellent, the outcome of years of study by the air force of a continental nation possessing a great army.

We had not developed this co-operation to the same degree because we had not been faced with the same problems. An island nation, we had built up and developed our air force to protect our trade routes and cities and to carry the war to the enemy's country by means of our bombers. The role of our small army was to protect this country and the bases of our Empire routes.

It is therefore true to say that in 1940, we had much to learn in the technique of intimate co-operation with an army in the field. One of the first steps was to discard the *Lysander*, which was the pre-war conception of the tactical reconnaissance aircraft. It is interesting to note that our views on this had been shared by the Germans who produced the Henschel 126 at the same time as we produced the *Lysander;* the two aircraft are almost identical. It was decided to rearm the tactical reconnaissance squadrons with a fast, well-armed and armoured aircraft, and for this we were fortunate enough to get the American Curtiss *Tomahawk* fighter. A technique for the close support of land forces on the battlefield was developed and our experience in Libya has since shown our method to be at least as good as that of the Germans.

With the successful invasion of Crete by air-borne forces a new problem emerged. Crete had been taken by a parachute-glider-air-borne attack, and suddenly sceptics of all services and all political parties remembered with a shock the ridicule with which they had regarded the Russian paratroop experiment of pre-war days. All this was an-

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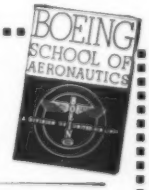

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other job for Army Co-operation—a job of which for reasons of secrecy, nothing can now be said. The combined operations raid at Bruneval, where radiolocation equipment was destroyed by paratroops at night, is, however, an indication of how it is being done.

Another Army Co-operation job of which, on security grounds, little can yet be said, is that of creating an air observation post for artillery. In the last war pilots and observers set out on a fixed task. Equipped with elementary wireless, the observer in the aircraft directed the guns 6,000 feet below him by a simple morse code formula. Fighter aircraft, either on offensive patrols across the lines or flying above him, gave him protection. His main danger was anti-aircraft fire.

Today the speed of fighters and the development of flak has made the 1914-1918 method of spotting hazardous and obsolete. It is still essential however for a gunner to know how and when his shells are falling, and his problem is very like that of the army commander, to whom accurate information of an enemy's movements and dispositions is essential. The supply of accurate information—the word *accurate* cannot be overstressed—has placed upon pilots and observers of Army Co-operation aircraft a great responsibility.

Since Army Co-operation pilots are required to supply military information, on which the course of an engagement may depend, it is essential that they should possess a sound basis of military knowledge. The pilot who can identify the mark of a German tank, who can recognise the difference between the types of guns moving along a road, who can comprehend the inference to be made from a column of motor cyclists with side-cars as against that suggested by a mere string of motor cyclists, is a person of far greater value than the man who sees merely a "mass of vehicles heading west along the road from — to —" and who has no means of identifying the types of equipment concerned. It is not enough, in fact, that an Army Co-operation pilot can fly. He must have a thorough knowledge of the German army, its armoured formations, its equipment and how that equipment is transported. He must be a military encyclopedia as well as an airman.

It is partly for this reason that there are no RAF intelligence officers on the strength of Army Co-operation Command squadrons. The intelligence brought back is, in fact, not of an Air Force nature. It is, in general, military information. Each Army Co-operation squadron accordingly works with a small air liaison section normally of three Army officers.

All these officers have been specially trained. They are picked men whose first duty is to brief pilots, to advise them on their selected tasks, to extract every possible scrap of military information from them when they return. Each of these sections has its own travelling photographic tender where the results of each photographic sortie are processed. To the Army liaison officer falls the job of making what is termed a "first phase interpretation" of the photographs brought back. This interpretation, like the verbal report of the pilot himself, is telephoned, radioed or sent by dispatch to the military commander of the force with which the squadron is working.

Considerable training in all this work is very necessary to Army Co-operation pilots. With all other pilots of other RAF Commands they pass through the usual flying training schools. But to this is added a course in the art of military manoeuvre. This in time leads them to the special training organisation of Army Co-operation Command which is centred in a group headquarters. Under it are special training units to instruct airborne troops, parachute organisations and training units working solely in anti-aircraft co-operation. The very nature of these units, all of which are superimposed on the many diverse and smaller activities which are part of the advance training side of the RAF, makes it impossible to say more of them. Like so many of the activities of Army Co-operation since Dunkirk they must remain military secrets.

END

Ferry Command

(*Continued from page* 104)

addition, and always he has to make certain that there is a sufficiency of them to hand—but, to avoid waste, no more than a bare sufficiency.

The ideal proportions of Atlantic ferry crews which I set out to attain, as the Canadian operational training units have come into fuller working order, includes approximately 70 per cent newly trained pilots and crews. On reaching Britain these men go to squadrons and do not return. The remaining 30 per cent are civilians permanently employed on ferrying. The latter, incidentally, normally return to Canada by air.

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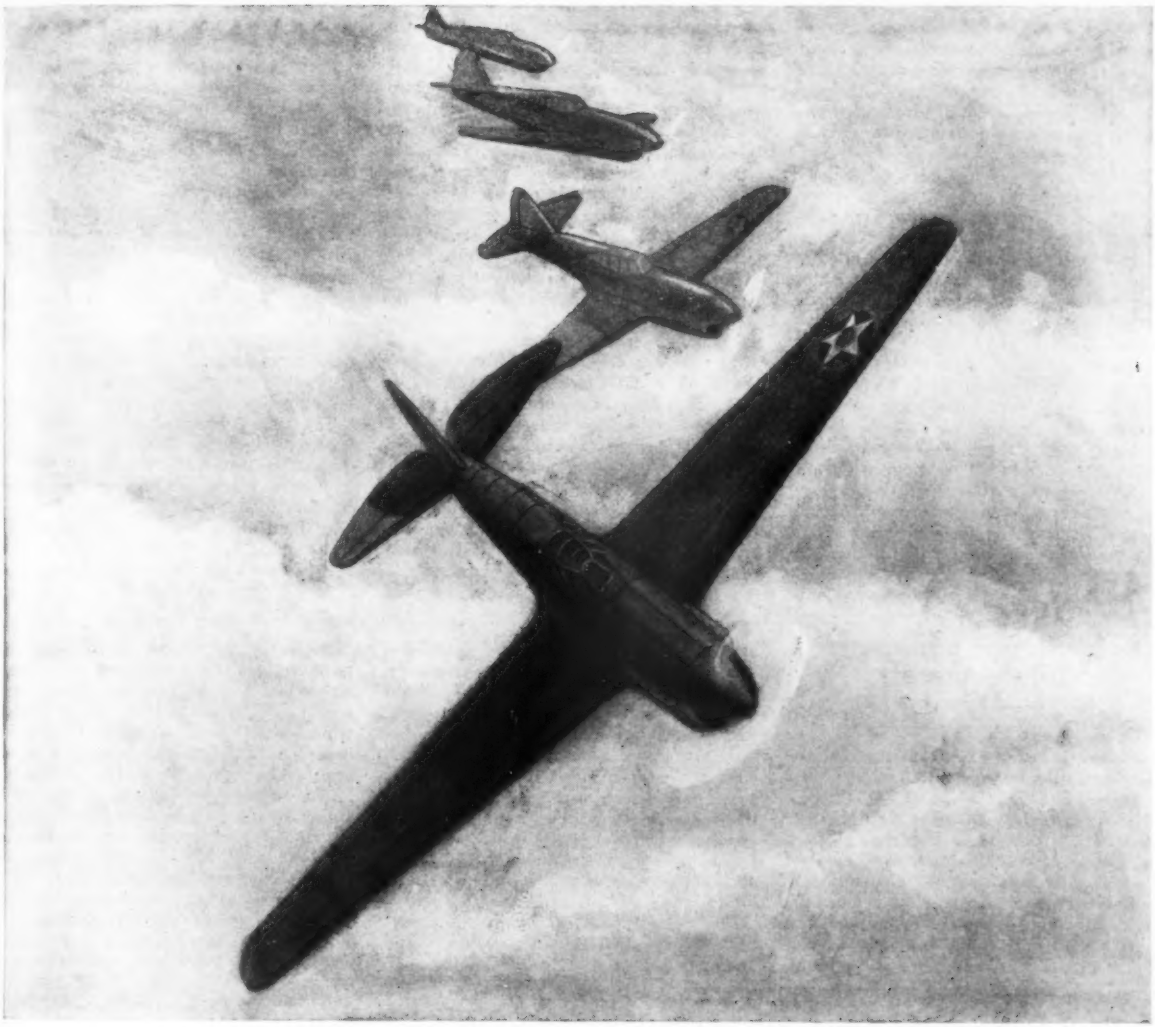

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Nearly all the navigators in the RAF Ferry Command are now service trainees who, like the pilots and wireless operator/air gunners do not return to us from Britain.

A training school has been established for civilian flying personnel for nearly two years. It was opened with the object of obtaining men with a minimum of 750 hours solo time holding a commercial licence and instrument rating and with some twin engine experience. About 75 per cent of these men are retained for ferrying work.

These civilian pilots come from all over the earth. Under the very severe tests which I apply to them if they are to be permanently engaged on Atlantic ferrying, only first-class men emerge successfully. Practically all of them would be regarded as too old for operational service in their national air forces, but they do great service by ferrying bombers to the younger men who will fly them in operations.

The Signals Branch of the Ferry Command has been organised on an immense scale and on the engineering side we have to supply men not only to Montreal but to places as far apart as San Francisco and Bermuda and into the Arctic zone.

The bogey of transatlantic flight has been laid by the meteorologist. The basic forecasts for the Atlantic flights are made at Dorval and primary forecast centres make a chain from Dorval to Bermuda, Newfoundland, Labrador, Greenland, Iceland and the west coast of Britain.

Bombers and flying boats crossing the Atlantic are well laden with urgently needed war material, Government mail and official passengers for all departments of the British Government and those of the U. S. and Canadian governments as well. A few months before the outbreak of this war leading experts in the U. S. and Britain were unanimously of opinion that it was impossible to found a winter airmail and passenger service over the North Atlantic. So it is worth recording, for the first time in history, a large volume of freight, diplomatic mail and passengers was ferried to Britain on regular schedules by bombers throughout last winter—the worst winter, I am told, in 30 years.

From the questions most commonly put to me by laymen regarding transatlantic flights, it is clear that the main point of interest is still the speed at which the crossing can be made. I do not allow this consideration to enter the mind of anyone under my command. It is, in fact, an offence for any of my captains to attempt to "beat records" which might hazard new and valuable aircraft. Each captain is given a flight plan by which he proceeds to Britain on routes, zones and altitudes according to the weather information from both sides of the Atlantic. The most economical speeds are fixed for each zone of the crossing and the captains loyally adhere to their flight plans.

The record of each transatlantic flight is sent back to me. The great mass of information thus obtained by a war organisation is collated in a form which will be invaluable to Great Britain, Canada and the United States when plans come to be made for post-war commercial air services over the North Atlantic.

END

British Aircraft

(*Continued from page 160*)

Pegasus engines of 1,000 h.p., the *Sunderland's* maximum speed is 210 m.p.h., with a range of 2,880 miles at 178 m.p.h. Loaded it weighs 45,700 pounds and has a span of 112 ft. 10 in., a length of 85 ft. 4 in., a height of 32 ft. 11 in., and a wing area of 1,487 square feet. Cruising out over the Atlantic on convoy protection, and on long-distance reconnaissance work generally, the *Sunderland* has shown qualities of reliability and endurance equal to the importance of its duties. Guns bristle from its nose and stern and from amidships on either side, and it also carries a substantial bomb-load. Endurance is its main characteristic; a *Sunderland* lately forced down through engine trouble in the South Atlantic was taken in tow by a Naval corvette and towed hundreds of miles through a heavy swell, a severe crosswind and bad electrical storms. The tow lasted 74 hours and the *Sunderland* received a terrible buffeting.

The Bristol *Beaufort* bomber and torpedo carrier flies at over 300 m.p.h. and has a span of 57 ft. 10 in., length of 44 ft. 2 in., and a height of 14 ft. 3 in. The twin engines are 14 cylinder sleeve valve air-cooled Bristol *Taurus*, of over 1,000 h.p., and this aircraft has done brilliant work for Coastal Command. Heavily armed, it is a first-class torpedo aircraft and bomber, carrying a crew of four.

That, roughly speaking, completes the summary of Britain's modern bombers. In addition, of course, the faithful old *Hampdens*, *Whitleys* and *Blenheims* continue to fly with the RAF.

A reference must be made to the British training aircraft. The first plane handled by a fledgling pilot is the famous De Havilland *Tiger Moth*, which has been

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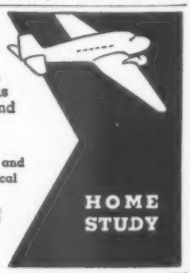

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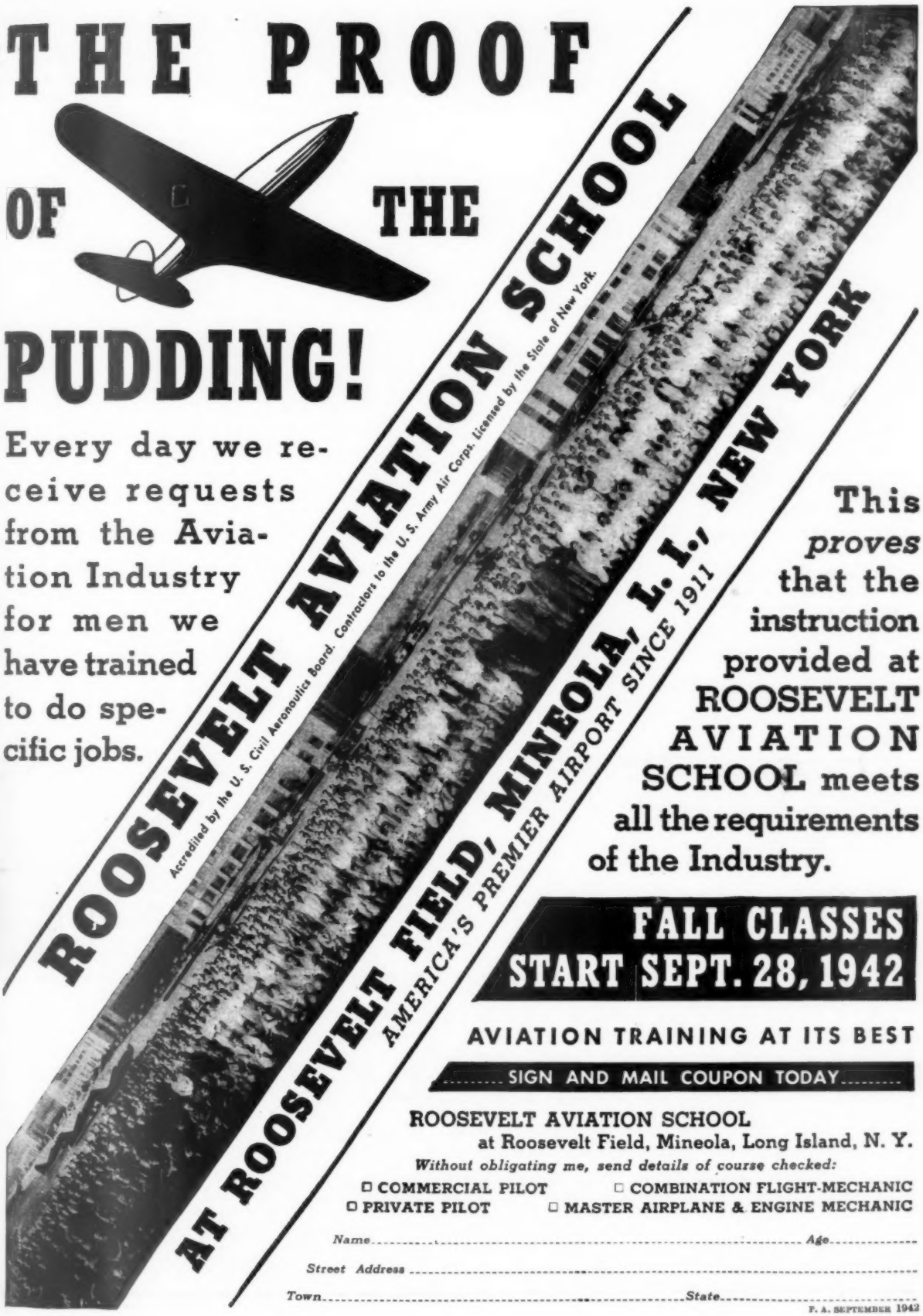

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so consistently successful in all sorts of flying over many years. It was on an early *Tiger Moth* that the late Amy Johnson made her amazing record flight to Australia years ago, and today's version of the *Moth* is one of the most efficient and reliable light aircraft in the world. Other trainers are the Airspeed *Oxford* and the Miles *Master*. The *Oxford* has a wing span of 53 ft. 4 in., a maximum speed of nearly 200 m.p.h. and a range of almost 1,000 miles; it is powered by two 350 h.p. Armstrong Siddeley *Cheetah* engines. The *Master* (built by Phillips and Powis) is a small and neat aircraft of excellent design; maximum speed is 250 m.p.h., with a range of 500 miles.

The Avro *Anson*, which did great work with Coastal Command at the beginning of the war, is now a trainer and communications aircraft. It has two *Cheetah* engines, a maximum speed of 188 m.p.h. and a range of about 800 miles.

Finally there are the modern British fighters. If ever a country owed a debt of gratitude, Britain owes that debt to Sidney Camm and the late R. J. Mitchell, designers—respectively—of the Hawker *Hurricane* and the Vickers Armstrong *Spitfire*. The *Hurricane* was always the most adaptable of the RAF's fighters, flying and fighting equally well in all countries and in all kinds of conditions. Its latest offensive armament now gives it many times the fire-power of the days of her youth, and many *Hurricanes* are even fitted with bomb racks beneath each wing for fast light bombing. The combination of increased power in the *Merlin* engine and of fire-power has made the *Hurricane* one of the most reliable and versatile fighter planes in the world.

The *Spitfire*—the schoolboy's dream—fought superbly in the Battle of Britain and has fought superbly ever since. Mitchell's design developed from his famous Supermarine seaplanes which won the Schneider Trophy for Great Britain. The latest *Spitfire* is a fast-flying fighter of exquisite lines; speed about 400 m.p.h., powered by a Rolls Royce *Merlin*, offensive armament includes two cannons and four machine guns. It is justifiably world famous.

The Bristol *Beaufighter* is the most heavily armed fighter aircraft in the world, with six machine guns and four cannons. It is used for night-fighting and long-distance fighting in which it has been notably successful. Its maximum speed is 330 m.p.h., and it is powered by two 1,400 h.p. Bristol *Hercules* radial air-cooled engines.

There are many other aircraft in the service of the RAF and the Fleet Air Arm; this short summary cannot describe them all. Its purpose has been to give as many details as may be given safely of the principal types of which Britain—and Britain's aircraft industry particularly—is very proud.

END

ATA

(*Continued from page* 173)

perience in Scotland. Flying a small plane at dusk in the depths of winter, his engine suddenly cut out and he was forced to land on a frozen lake. The plane immediately caught fire, and while he was pluckily trying to rescue his log-book, the ice melted and dropped him,—and after wards the plane—into the cold black water. He pulled himself out and somehow found his way to a crofter's cottage, where he found welcome and shelter for the night. In the morning he managed to find a railroad, jumped a slow goods-train and arrived at his base at the end of 24 hours, still in his sopping kit. "That's nothing," he said cheerfully, "I'm quite used to duck-shooting."

Every pilot, men and women of the ATA, doing a Herculean job with no fuss and no show, are there because they want to be. They have the luck to be doing a job they love for its own sake as well as for its value to the country.

Within the last few months, American women have come into the Service, headed by Jacqueline Cochrane (Mrs. Odlum), who made history by arriving here with a bomber sent by the U. S. A. Among several Polish women pilots now serving, is one who served her own country with great distinction throughout its tragic campaign, Miss Anna Lesics. Another girl from Chile, Margot Duhalde, has seen much service in the ATA.

The other day, three *Spitfires* were urgently needed at one of the fighter stations. Flown at top speed, one after another, by the same ferry-girl, they were in battle in the sky within a few hours. This is merely an example of the ATA's daily round, which is linked so closely to the efficiency of the RAF.

But *Spitfires* are straightforward goods. Perhaps the toughest delivery job handed to the Ferry was a consignment of American aircraft destined for France. It was an order from the French Government, but at the fall of France the planes were diverted in transit to this country. Every instrument was labelled in French with unfamiliar technical names, and for some peculiarly Gallic reason, the throttles were reversed on each machine.

The Ferry service operates from pools dotted over the country and linked to a Headquarters which until recently included the Training School. This has now expanded to more spacious premises elsewhere. On a control-board, the names of the pilots are starred with different colours indicating the number and grade of aircraft each is capable of handling. Orders for the day, streaming in from factories, salvage and maintenance depots, ports and RAF stations, are allocated according to available pilots experienced in operating the aircraft concerned. Infinite organisation is required to man the various types and ensure minimum loss of time. The ATA's own planes are maintained by ground staff, men and women, attached to each different pool. Clerical staff and motor transport are also an integral part of the organization; many of their transport drivers have already seen hard service in France.

The King and Queen recently marked their recognition of the ATA's signal services by a visit to headquarters, where they met and talked to the pilots and showed special interest in the American men and women who have come over to take a hand.

Of all the multitudes of people giving of their best to this country today, none have gone about their business with greater pluck and determination than the ATA. They have been very fortunate in the leadership of a man—Commodore d'Erlanger—who has the respect and liking of everyone under his command, and in the example of Pauline Gower, whose friendly charm is only equalled by her immense ability. These two people have set the standard by which their achievement may be judged.

END

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Middle East

(*Continued from page 85*)

The RAF still had an epilogue to write to this story. The few remaining *Blenheims*, acting as fighters, patrolled over the crowded ships on their way to Crete and chased German bombers off before they could attack. The *Sunderlands* and transport flying boats carried out splendid work ferrying parties of airmen and soldiers from Greece to Crete and from Crete to the mainland. One *Sunderland* put up a remarkable record by carrying 84 people in a hull built to hold few more than 10. We had been thrown from the mainland. Now we held an island. For the moment we stood at Crete.

The battle for Crete illustrates, perhaps more vividly than any other operation, how the struggle for aerodromes may be the key to land, sea and air operations. Even before the capture of Greece was complete the enemy were preparing further aerodromes in the south of the Peloponnese and in islands in the Southern Aegean. By the time the attack on Crete was launched, there was a semi-circle of aerodromes on the islands and in southern Greece from which fighters and dive bombers could operate. Behind that were the main aerodromes in Greece, which were now hard and firm and from which bombers and transport aircraft could operate in large numbers.

On Crete itself, owing to the mountainous nature of the island, the possibilities of aerodrome construction were very limited. For some time beforehand the construction of landing grounds had been pushed ahead and three landing grounds had been prepared, but Middle East resources had been skinned to supply the force in Greece and the scale of defence available for these new airfields was meagre. Further landing grounds had been begun, but since means for defending them were not available, in so far as it was possible they were made useless by obstructions.

The most serious threat to Crete was obviously that of airborne attack. We were therefore faced by the paradox that landing grounds on Crete were both a necessity for defence and a menace in event of invasion. The Battle for Crete was literally a battle for the three landing grounds of Maleme, Retimo and Heraclion.

For the defenders of Crete it was a battle against overwhelming odds. The depleted air forces in the Western Desert were already near the low water mark and the mere replacement of the heavy wastage in Crete was a severe strain.

The 350 miles of sea between Maleme and our nearest bases in the Western Desert made it impossible for *Hurricane* squadrons in Africa to operate over Crete from their African base, whereas the enemy short range fighters from their new bases in Southern Greece and the islands could operate with ease over Crete, escorting bombers and carrying out low-level attacks. This was the fundamental handicap from which the defence of Crete suffered. It was decided that it was useless to attempt to operate aircraft from the aerodromes on the island.

During the three weeks before that decision was made that small fighter force, composed largely of the remnants of squadrons from Greece who had been fighting hard for months and were short of many items of vital equipment, put up a gallant defence against impossible odds.

In the meantime, *Wellingtons* operating from bases in Africa made a series of heavy night attacks on the Greek aerodromes where the enemy was massing his air invasion, and *Beaufighters* carried out a devastating low-flying attack on the massed Junkers Ju-52's at dawn. The bombing forces available were quite inadequate to stop the invasion, but there is no doubt that they were effective in slowing down the enemy's preparations and delaying the actual attack.

The airborne invasion began on May 20, the enemy selecting Maleme as his principal objective. Heavy bombing and machine-gunning raids were carried out early in the morning, especially against our A.A. positions, and from then onwards parachutists were dropped at numerous points. A number of Ju-52's crash-landed on the beach adjoining the aerodrome and added to the strength of the assault. Further parachutists were dropped to the west of the aerodrome late in the afternoon.

Carea Town was heavily bombed, and the landing of parachutists was continued at Heraclion and Retimo. At all points enemy losses were considerable, but at Maleme the Germans gained a footing and drove our forces to positions two miles east of the aerodrome. On the first day of the invasion it was estimated that over 7,000 parachutists were landed.

On May 21 and 22 the enemy made two attempts to send in reinforcements by sea. The first convoy was destroyed and the second scattered by our Naval forces. No seaborne attackers reached Crete. Our ships were, however, operating inside the ring of enemy air bases, literally within sight of Melos. Fighter cover over Crete was negligible, but it was even less possible for the fleet, well north of the island. Thus, as a result of heavy and repeated dive bombing attacks throughout the day, our naval losses were severe. Day after day, however, a steady stream of German air transport poured troops into Western Crete, while continuous bombing and low-flying attacks battered the defence. The fortunes of the fighting swayed to and fro until May 26, when it became clear that the situation was deteriorating fast. On the following day plans were made for evacuation which commenced on May 29, and was largely concluded by June 1.

Analysing the second phase of the operations—that is, from the time of the actual invasion to the evacuation—it was evident that for a successful airborne attack the enemy had to secure a high measure of local air superiority. Only thus could the massed dropping of parachutists be achieved and the supply of materials and reinforcements maintained.

Crete established beyond all doubt that the capture of an aerodrome is the pre-

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requisite for the success of an airborne invasion.

For the RAF the Crete campaign can be likened to operations against the southern apex of a triangle the whole area of which was in enemy hands. In the face of great odds, pilots, ground crews and other personnel fought with outstanding courage.

Even while we were fighting desperately in Greece, the enemy had attempted to cause diversion by fifth column activity. Rashid Ali, a notorious pro-German intriguer, raised a revolt in Irak, and invested the RAF camp at Habbaniya. The defence of this flying training school by the instructors and pupils with their training aircraft is an epic in itself that deserves to rank high in the RAF's achievements in the Middle East.

Habbaniya was surrounded by the Iraqis during April 30 and May 1, their force consisting of roughly 4,000 to 5,000 troops with 30 field guns, some pom-poms and about 150 machine guns, and supported by armoured cars and light tanks. Their air strength was put at 70 aircraft, 50 of which were superior in performance to anything possessed by the training school. The latter, in fact, had 65 aircraft that could be used for operations. There were only about 35 pilots available, of whom the majority were either instructors with little or no operational experience or pupils with none at all.

The land force comprised 1,000 Iraq levies and about 150 King's Own Royal Regiment. There were 18 RAF armoured cars. A small number of trench mortars mounted in concrete block houses completed the defence. There were no field guns at all. Improvised bomb racks were fitted to the training aircraft and the flying training school went forth to fight.

During five days 647 sorties were made. Over 3,000 bombs were dropped on the enemy, and 116,000 rounds of ammunition were fired. Meanwhile a strong force of *Wellingtons* from Egypt was moved up to attack the Iraq bases and petrol supplies, while continuous patrols over the enemy positions did much to stem the rebel activity. The arrival of German aircraft to bolster up the rebels was a nuisance, but it was marked by the shooting down of the first two Messerschmitt Me-110's by *Gladiators;* and it did not unduly delay the issue, for by that time some experienced squadrons from Egypt had arrived on the scene. Sedate Vicker's *Valentias* brought in arms, ammunition, and troops. The situation, which at the outset had looked serious, was well in hand. In fact, the revolt collapsed with the same suddenness that had characterised its outbreak. Great credit was due to the RAF armoured cars which bore the brunt of the early attack and which were in at the kill.

The campaign in Syria was brief, but was noteworthy for the effective manner in which the hostile French air force was knocked out, partly in combat, despite the arrival from Vichy, France, of a considerable number of specially selected and experienced fighter pilots. The low-flying fighter attack once again proved its efficiency.

The campaign in Iran was even shorter and the part played by the RAF consisted of fighter support against possible enemy attack; tactical reconnaissance in support of our ground forces; air transport of troops and leaflet dropping.

During the Greek and Cretan campaigns there was still a threat in the Western Desert. The handful of aircraft and the skeleton force, which was all that had been left there after the reinforcement of Greece, had been unable to withstand the advance of the Afrika Korps and had retreated right back to the Egyptian frontier. An important exception, however, was the Tobruk garrison, now reinforced from the sea.

Rommel was now in the same dilemma as that in which General Wavell had found himself at El Agheila. Why did we not proceed to Tripoli? Why did he not advance on Alexandria and Cairo?

Rommel could not do so immediately because he had first to accumulate a large stock of war materials on the Egyptian frontier. During that pause the few RAF fighters and bombers still operating against him concentrated on his lines of communication, and at night the heavy bombers struck at Benghazi, filling the harbour with wrecks and crumbling moles. Great care had to be taken to conserve what aircraft we possessed, but despite this disadvantage much dislocation was caused on the enemy lines of communication along the roads from El Agheila to Sollum. It is not too much to say that the interruption of these supplies by our fighters, aided by medium bombers in the day and at night by the *Wellingtons,* halted Rommel in his projected

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invasion of Egypt just long enough to enable the British forces to grow stronger again.

Again it was a question of usable aerodromes. The enemy once more held the Cyrenaican plain. His air bases, which ringed Tobruk, forced us to withdraw aircraft from that garrison, leaving the air free for German bombers.

But in spite of that, the RAF continued to hammer at enemy communications so that the bulk of the Italian fighter force was dispersed in defending the rear areas. Though in theory outclassed and outpositioned, the RAF stayed on the offensive, forcing the enemy to the passive role of defence. In an effort to stop the daily toll of their transport, the Germans put an armoured vehicle every five miles along the roads.

Now there was a lull in the north, a period of gathering strength in the desert. But all this while a smaller but highly successful campaign had been in progress in East Africa, and now was moving to a decisive stage. The Italians were greatly superior in numbers in that theatre, both on the ground and in the air, but the only real use which they made of their strength was to capture British Somaliland in the autumn of 1940, and to make some small advances into Kenya south of Moyale.

In the air we had three small forces with which to oppose the enemy and with which, during the spring and summer of 1941, to vanquish him. In the south of Kenya were a few South African squadrons flying such antiquated aircraft as *Battles*, *Gladiators*, *Furies*, *Hartebeestes*, Junkers Ju-86 [Prior to the outbreak of the war, the British South African Airways purchased a number of Junkers Ju-86 transports. These were converted to warplanes.—ED.] and *Ansons* but with a leavening of *Hurricanes*. To the north in the Sudan there were five squadrons equipped with *Hurricanes*, *Gladiators*, *Wellesleys*, *Blenheims* and *Harts;* while in Aden there were some *Blenheims*, *Wellesleys* and *Gladiators*. The country over which these aircraft had to fly was a nightmare of mountain, jungle and swamp where a faulty engine probably meant death. Yet, in support of the ground forces, these squadrons helped to drive Italians right out of East Africa and Abyssinia and to restore the Lion of Judah, the first victim of world agression to be reinstated.

This is how it was done. The Aden air force kept the Red Sea and bombed the Italian supply ports. The South Africans drove up from Kenya with the ground forces as far as Addis Ababa, which was captured on April 6, the day that the Germans struck at Greece. The air force from the Sudan in the north, composed of four RAF squadrons and one South African squadron, struck at Keren. This stronghold having fallen on March 26, Massawa and Gondar could make no effective resistance. The final advance took some little time, but Gondar surrendered in November.

This was not a campaign on the grand scale, but a single glance at the map shows that it was a brilliant achievement. Farther north there were more important things preparing. The heat of the summer was waning from the Western Desert. No longer did a man's hand blister when he laid it on the outside of a tank or on the fuselage of an aircraft. It was campaigning weather again.

At first light on November 18, the Air Forces in the Western Desert moved into action with the Imperial Armies for the assault on the Axis forces in Cyrenaica. Their aim was to gain air superiority, to afford protection for the armies against enemy air interference, and if possible to destroy the Axis air forces. Throughout the summer considerable reinforcements of aircraft and personnel as well as equipment of all kinds had reached our bases from Great Britain and the United States, and much reorganisation and intensive training had been carried out, particularly among the fighter squadrons, in preparation for the campaign.

The objects of the second great offensive were the removal of the threat of invasion to Egypt and the Suez Canal; the establishment of air bases suitable for raiding Italy, Sicily, Greece and Crete; to gain greater freedom of movement for our shipping in the Mediterranean; and to compel the enemy to reinforce from the other fronts—particularly from Russia, where the Soviet armies, now for four months our Allies, had their backs to the wall.

In the first week of the battle some 30 bombing sorties were made against enemy ports and bases, while nearly 360 were directed against enemy positions and lines of communication. Fighter action was particularly intense, and in the same week over 1,000 sorties were made. This latter figure gives a clear indication of the close support given by the fighter squadrons to the ground forces.

Air operations, which had already been considerable, reached maximum pitch on November 18. Fighters ranged deep into enemy territory, shooting up aerodromes and attacking motor transport, personnel and encampments wherever they were found. By midnight on November 23, 118 enemy aircraft had definitely been destroyed.

The battle of the triangle in the area bounded by Fort Capuzzo, Gabr Saleh and Sidi Resegh began on November 20, the main enemy armoured strength being encountered.

The week from November 25 to December 2 showed an extremely confused situation. The main battle developed to the west, east and south of Sidi Resegh. An enemy column, with great daring, had pushed through the advancing British troops to the Egyptian frontier, and had then turned north and west. Our eventual success in thwarting this manoeuvre behind the main area of battle can be partially attributed to the air superiority we had obtained. After reverses at Sidi Resegh and Bir El Hamid, our land forces re-formed and the offensive was resumed. In the Bir El Gobi zone the enemy were pushed back and first withdrew towards El Adem; but on the night of December 8 they abandoned this important aerodrome and moved still further to the west.

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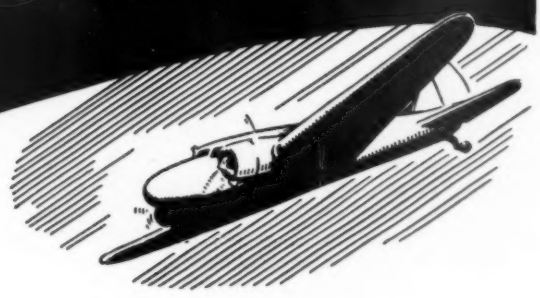

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The Axis retreat gradually increased in momentum until on December 16, the enemy was holding the line from El Cheima to Gazala. But, owing to the failure of his counter-attacks, the losses he had incurred and the outflanking tactics employed on his right wing, his situation was rapidly deteriorating. Bad weather hindered air operations, but the fighters still flew almost continuously above the battle.

From this point onwards, the enemy retreat became perilously rapid.

Nevertheless the advance was proceeding at such a pace that it became more and more difficult to correlate the forward movement of the fighter squadrons with the maintenance of their full operational strength. Sacrificing great quantities of equipment the Axis armies continued their flight and took up new positions in the Antalat, Soluch and Jedabaya zone, where at first they were assisted by aircraft operating from Sidi Amed El Magrum. Twenty-four *Wellingtons* attacked this aerodrome on the night of December 21, the raid being followed by a low-level attack in the morning, two bombing attacks at mid-day and a heavily escorted bombing raid in the evening. At least 16 enemy aircraft were confirmed as destroyed.

Our forward elements entered Benghazi on December 24 and reported that the harbour had been devastated by bombers. The North Mole was wrecked at several points and the central Mole blocked with sunken ships. Eventually the enemy was compelled to withdraw to Jedabaya and beyond. Our air forces, however, had been left with the task of overcoming Axis strongholds far to our rear, the isolated garrisons of Bardia, Halfaya and Sollum.

In the forward area, where our air forces had been reinforced by American *Kittyhawk* fighters, the enemy withdrew to the Agheila "Bend." The weather continued to be bad. Heavy rains and difficult communications, as well as the necessity of re-forming the land armies for a further attack, brought our advance to a halt. A lull set in, broken only by fighter and bomber operations.

Then Rommel suddenly pushed forward his remaining tank and armoured strength to test our holding forces. He captured Jedabaya, found the opposition much weaker than he expected, and pushed on. Antelat and M'sus were recaptured by the enemy, together with considerable supplies of all kinds. The counter-offensive proceeded north and northwest in two columns, one towards Mechili and the other in the direction of Benghazi.

Compelled to withdraw, the Air Force put up a magnificent display, perhaps the finest of the whole campaign. In fearful weather, in conditions under which a few weeks before the German air effort had been practically nil, our aircraft attacked the advancing enemy continuously. Hundreds of his motor vehicles were destroyed and losses among his troops were very heavy. Enemy air opposition was negligible, Rommel having decided that, his fuel being limited, it was more important to supply his tanks and armoured vehicles than his aircraft. The enemy columns advanced without air protection, proving that it can be done if the ground forces are prepared to suffer heavy losses.

Though our great thrust ended in considerable withdrawal, many of its aims were achieved and, if the captured territory was abandoned, the dislocation of enemy forces and the complete shattering of his plans remained valuable gains. Suez was farther off; the Rommel legend had been roughly handled.

After several months of quiet during which time Marshal Rommel brought in large reinforcements battle flared up again on May 26th, 1942. Then began days of fiercest fighting which Allied Air Forces had ever experienced in Western Desert. For 36 days our pilots and ground crews were fighting in support of stout efforts of the 8th Army which was suffering severe punishment until the main British Forces came to halt at the back of the El Alamein line. Allied fighter pilots were flying *Kittyhawks, Tomahawks, Hurricanes, Beaufighters* and a few *Spitfires.* During the day we were using *Bostons* and *Baltimores* for bombing and at night time our *Wellingtons* with *Liberators* of the United States Army Air Forces carried on good work. Throughout fateful days Allies never lost their air superiority. This was entirely due to fighting spirit of air crews and unselfish work of ground crews.

The battle moved on. Bir Hachein held by Free French fell. The battle milled round Knightsbridge and then further east towards El Adem. Air tactics changed. It was of paramount importance that close support should be given to ground forces. *Bostons* and *Kittybombers* mercilessly attacked Axis panzer and supply columns. So well did our fighters protect *Bostons* that it was not until July 7 that one was shot down by enemy fighters. Four separate enemy attacks in three days in El Adem area were brought to standstill by air attack alone. But the land battle continued to move eastwards and our troops withdrew from the Gazala area.

As the battle continued to move eastwards our bombers and fighters put on an amazing spurt. Pilots and aircrews many unshaved and unwashed climbed in and out aircraft many times a day taking off, bombing and fighting, landing to refuel and taking off again on another sortie. During this phase of the battle our aircraft operated nearer to mobile front line than aircraft had ever done before. Fighter pilots and ground crews were among last to cross the Libyan frontier into Egypt. The withdrawal from aerodrome to aerodrome was a remarkable piece of work. In November when Germans and Italians retreated from Egyptian frontier to Aghaila in Tripoli they left behind more than 400 damaged aircraft. When Allied forces withdrew from Libya on June 17 only five damaged aircraft were left behind, all having been destroyed by our crews. No equipment was left. It was a triumph for ground personnel of RAF and particularly for salvage units. While the 8th Army was

(*Continued on page* 270)

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consolidating positions in the El Alamein area Allied Air Forces continued night and day to pound the enemy. They carried out more than 500 sorties during each 24 hours. This relentless hammering helped materially to prevent battle weary German and Italian troops from continuing advance. That was still the situation at the middle of July.

There remains a tremendous epilogue—Malta. But since it is an epic in itself a separate chapter is devoted to the story, which another hand must tell in full.

END

East of Suez

(*Continued from page* 78)

Palestine and Transjordan. He has been Deputy-Chief and Vice-Chief of the Air Staff. He served during the greater part of the last war in the Royal Naval Air Service and was awarded the D.S.O. in 1915, for carrying out repeated attacks on German submarine bases at Ostend and Zeebrugge.

Within a few days of the actions off Ceylon, enemy naval forces were successfully attacked by U.S. Army Air Force units operating Boeing *Flying Fortresses*, and since then the docks at Rangoon have been raided whenever conditions were favourable. Extensive air patrols for reconnaissance and protection of shipping have also been established. Meanwhile, the rapid expansion of the India Air Force continues. Founded in 1932, it has since made highly creditable progress for it has inexhaustible resources of first class manpower on which to draw. The youth of India has always excelled in sports demanding quickness of eye and deftness of touch. They have proved to have a natural aptitude for flying. For some years India Air Lines have successfully employed India pilots, and flying clubs have always been popular.

What India airmen could accomplish was shown during the Waziristan revolt when they operated with the RAF over what is perhaps the most difficult flying country in the world. In maintenance work they show the same skill. Tributes paid to their efficiency have been abundantly justified. As for courage, some hint was given by an Indian pilot who led the attack on Burma and, in face of stiff opposition, accurately bombed the target from less than 500 feet.

While the selection of personnel presents no difficulties—the Indian Air Force was overwhelmed with applications as soon as lists were opened—equipment is another matter. Lines of supply are long and difficult. But the industrial resources of India are being mobilised and expanded. Aircraft factories already are in the first stages of production and the Government of India representative is a member of the British Supply Board in the United States. Machine tools and other manufacturing equipment have been bought in very considerable quantities. As for the supply of skilled labour this has proved more than adequate both in numbers and in its standard of technical accomplishment. Given time, India may produce a quantity of material for her own defence.

The Japanese advance must be held and their lengthening communications subjected to damaging attack from air and sea. Meanwhile, aircrews from the training station at Risalpur and mechanics from Ambala will be helping form an air force of power which can operate decisively when the time comes for a general offensive to be undertaken.

It is useless to overlook the possibility that before these words are in print the enemy may have struck further serious blows at the cause of free nations. But none who have seen the India Air Force in action can doubt that defence of their country from the air will be conducted in conjunction with the Royal Air Force with gallantry and determination. Hindus, Muslims, Sikhs, Parsees and Bengalis fight side by side in its ranks. In the fellowship of the air differences of race and creed are forgotten. That the forging of this weapon in which the highest tactical and spiritual unity is demanded may aid the forging of that greater national unity of which it is a symbol must be the earnest hope of men of good will.

END

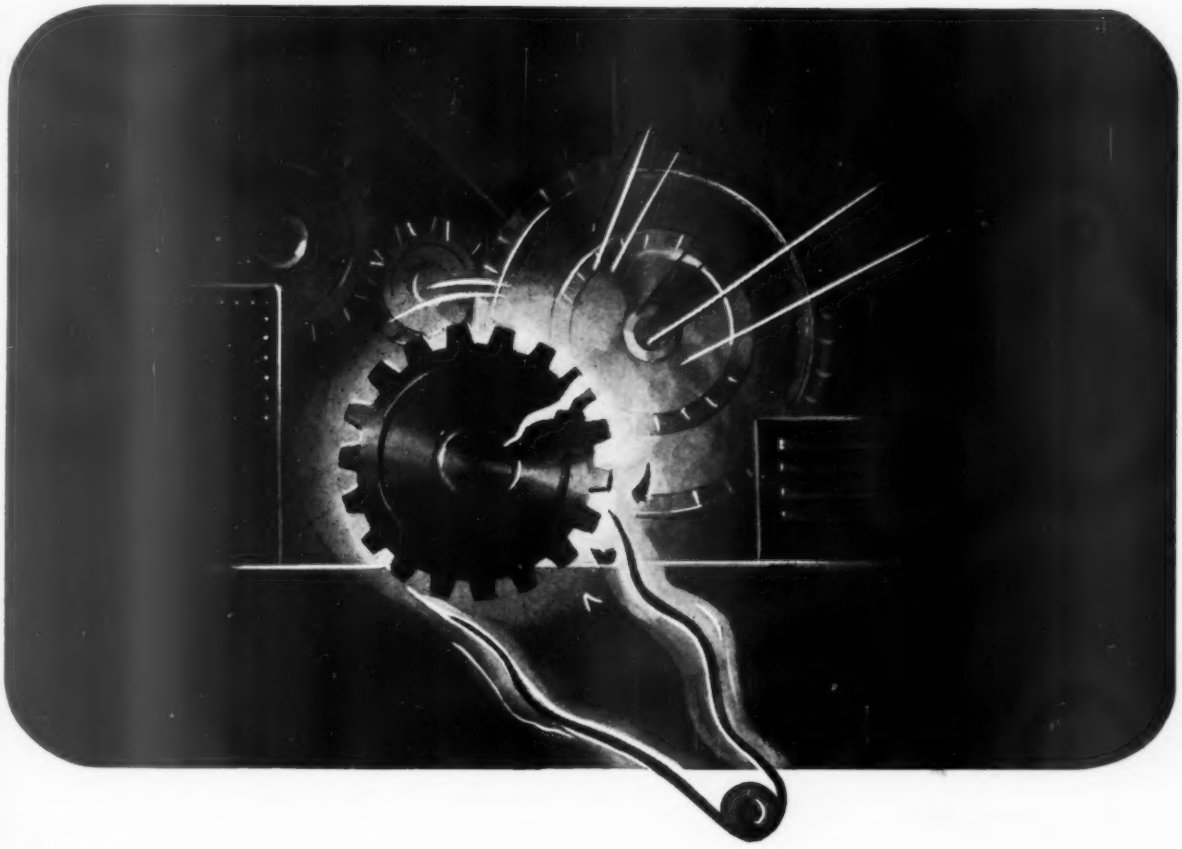
Maintenance Command

(*Continued from page* 101)

salvage of both aircraft and marine craft. Only about 10 per cent of the aircraft repairs are done in the Command's own repair depots; most of them are done by the aircraft manufacturing firms. The depots are however an excellent training ground and most of them have a staff turnover of almost 100 per cent in the course of the year, for as soon as mechanics have reached a high level of skill they are sent to the airfields both at home and overseas to deal with the maintenance problems of our constantly expanding air force. The large repair depots and salvage and repair units are so organised that minor crash or flak damage can be put right in record time. In the early evening you may see perhaps a *Wellington* bomber with a brand new appearance standing ready for take-off, while the pilot is receiving final instructions. It can't be fresh from the factory or it wouldn't be here. Last night in fact, it was over Bremen, where flak shot away part of the fuselage, damaged the port engine, and twisted a tail fin pretty badly. Altogether it was a sorry sight when it came in during the morning for repair. But the repair gang, men and women, swarmed on to it, each one going straight to a particular job, and by concentrated effort they got it ready for the take-off before dark.

Often a damaged aircraft which has made a safe landing on its return from a raid will be flown to the repair depot the next morning; but when there has been a crash the salvage squad comes into action. There is usually one salvage headquarters to an area about the size of two counties. The pressure under which this branch of the service works varies

(*Continued on page* 277)



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Photography

(*Continued from page* 137)

hundreds of miles away from the base and many hours after the cameras have been set. When it is remembered that light varies with time of day and period of the year, and also with latitude and longitude, it will be seen that there are a good many factors to be thought of. Exposure tables of a sort were available at the outbreak of war, but as the scope of operations widened, special tables were worked out based on service data which covered the whole globe. Copies of these tables are to be seen in every section and are used in conjunction with the pilot's reconnaissance report which contains the necessary meteorological information and the anticipated time and duration of the period over the target. With these data it is nearly always possible to make an accurate assessment of the exposure. On his return from the sortie, the pilot records the actual conditions under which the exposures were made in the photographic reconnaissance report, so that on further reference to the exposure tables the photographer can check their accuracy from actual experience. Under adverse weather conditions, or when avoiding action has caused delay, the resultant errors in exposure can still be partially corrected by giving the film special processing treatment for known under or over-exposure.

Processing in the RAF has been highly standardized and is entirely carried out by the time-temperature method. By this means it is possible to produce uniformly high quality even in processing individual spools of film from day to day. On the small sections, which handle only short lengths of film, the spool developing unit is still employed and fresh developer is used for each spool to ensure that no loss of quality results from stale or partially exhausted developer.

A small army of photo finishers, airmen and WAAF's are kept busy day and night turning out the prints for the various Intelligence branches. Here again it is vital that quality shall be maintained. The Intelligence officers are mainly concerned with microscopic detail in shadows and highlights, and if photography is to play its part none of this must be lost. On small sections this work is done by expert photographers, but on larger sections machinery has again been brought into play and automatic printing machines capable of handling up to 600 prints an hour keep pace with the ever growing demand for more and more pictures. Although most of the requirements of the Intelligence branches are fulfilled by contact prints from the negative, map-making to scale requires accurately scaled enlargements of matched quality which can be mounted together to form a composite picture of a whole district. Even in peacetime and when flying conditions are ideal, the task is a tricky one, but in wartime, when the pictures may have been taken by different aircraft flying at different heights, the task imposes the most searching tests on the skill and patience of the photographer and much depends on the personal care and attention which he bestows on his ground work.

But since they know the great personal risks which the aircrew have taken to bring back the photographs, sometimes with the grisly reminder of a camera full of bullet holes, the technical staff consider no pains too great to extract the last ounce of value from the negatives; and when they compare shots "before and after" and note the accurate destruction to which their work has contributed, theirs too is the grim satisfaction that they are pulling their weight in the war.

END

Honours List

INITIALS appearing after the names of authors in this issue, as well as after the names of various other prominent British experts mentioned in the articles themselves, indicate the honours that have been conferred upon them. Several of these honours are well known by their initials; the majority are not. Following is a table of the more prominent honours mentioned throughout this issue:

Bt.	Baronet
K.T.	Knight of the Order of the Thistle
C.M.G.	Companion of St. Michael and St. George
M.P.	Member of Parliament
G.C.B.	Knight of the Grand Cross of the Bath
D.S.O.	Companion of the Distinguished Service Order
M.C.	Military Cross
K.C.B.	Knight Commander of the Bath
C.B.E.	Commander Order of the British Empire
K.B.E.	Knight of the British Empire
C.I.E.	Companion of the Order of the Indian Empire
O.B.E.	Officer Order of the British Empire
A.F.C.	Air Force Cross
D.F.C.	Distinguished Flying Cross
C.B.	Companion of the Bath
C.V.O.	Commander of the Royal Victorian Order
G.B.E.	Knight or Dame Grand Cross of the British Empire
M.B.	Bachelor of Medicine
Ch.B.	Bachelor of Surgery
T.D.	Territorial Decoration
D.L.	Deputy-Lieutenant
M.A.	Master of Arts
M.B.E.	Membership of the Order of the British Empire

Box Score

SINCE the beginning of the war, the Royal Air Force has bombed Germany 486 times—*excluding* leaflet raids. Cologne leads all other German cities with a score of 106 raids; the city closest to Cologne in claiming that dubious honor is Bremen, with 94 raids.

Other scores include the following Nazi cities, followed by the degree of attention accorded them: Hamburg, 89; Hamm, 87; Emden, 75; Kiel and Wilhelmshaven, each with 63; Mannheim, 54, and Berlin, 53.

Allied Air Forces

(*Continued from page* 148)

Free French have taken part in sweeps over the Channel and over France. Many escaped by way of the French North African Empire, and one of these, now on fighter operations, probably holds the record for impudence and daring among all escape stories. Having escaped twice from the Germans in France, he ultimately reached Oran. There he was awarded the Croix de Guerre. At the conclusion of the presentation ceremony, together with other decorated pilots, he was to give a display of flying over the aerodrome. Instead of taking part in the display he calmly broke formation and flew to Gibraltar. Many of his comrades made longer journeys. The Tahitian members of the Squadron—said to be the best trained of all the French ground staff—came by way of Australia and New Zealand.

Many Belgians, too, were able to escape through North Africa. Some had been trained in France, and after the French capitulation escaped through Bordeaux. Others made straight for England where they found that the methods of RAF training and those of the Belgian Air Force had points of great similarity.

All these nationals had a common purpose in escaping to England. They were victims of a tragic repetition of history. In each of them aggression, designed to annihilate, had succeeded only in inflaming the national spirit.

Nor must we forget the gallantry of the Greeks and Yugoslavs in saving some part of their air forces instead of surrendering to the invader. When these countries were savagely laid waste they followed the noble example of other European nations, crossed the sea by ship or in their own aeroplanes, and are continuing the fight for freedom in the Middle East.

There is a grim side to the building-up of the air forces of these exiles, which those who have not known the cruelty of invasion are apt to forget. Many have given their lives; some are wounded, crippled or prisoners of war. Nearly all have left their homes, their wives and children to starvation, want and the brutalities of the invader. Many have never heard from their relatives since they left their native land and have no knowledge of their whereabouts or whether they are alive or dead. Not a few hear, by devious means, that their relatives or friends have been shot, either for opposition to the occupying Power or merely as hostages. But their struggle goes on.

Meanwhile the air power of the United Nations grows daily. The organized combination of the air strength of 40 to 50 of the great nations of the world is no longer merely a moral gesture. It is a revolution—a revolution that in time many be the basis of another. For we have often been told that, in any future peace, the world will need an international air force to keep it at peace. May it not be here?

END

Research & Development

(*Continued from page* 169)

months ago. Their explosive force is almost unbelievable, and they are shattering the German war machine. A single bomb dropped on Emden, for example, entirely devastated an area of 40,000 square yards. Months of development went into the making of that particular type—and other, even deadlier, types are in preparation.

Developments in the firepower of our fighters have also been remarkable. A Bristol *Beaufighter*, for instance, recently fired a quick burst at a Dornier in a head-on attack. With a roar the German flew into fragments, and the *Beaufighter*—its pilot temporarily blinded by a dazzling shower of sparks—actually flew, at 300 m.p.h., clean through the place in the sky where the Dornier had been only a second before.

Now that the U. S. and British air forces are flying together the task of standardising as far as possible the aircraft and weapons of the two nations naturally arises. Many problems have still to be considered. For example, in Britain we have a very large capacity for producing bombs by casting, whereas in the United States the majority of bombs are produced by fabrication from steel plate, a method not available here.

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Fortunately, British and U. S. guns are freely interchangeable. The British 20 mm. cannon was adopted for service in the United States practically as it stood, and conversely the development of a .5 inch weapon cost Britain no effort, since the Colt design was adopted without change by the RAF.

Until about a year before the war the Royal Air Force had no organisation for developing ammunition to meet their own special requirements. In fact, they accepted the types of ammunition found satisfactory by the other two services. A full scientific analysis of the values of all known types of ammunition for air to air combat purposes resulted, however, in a complete change of outlook and specialised ammunition has since been developed at high speed.

The results were so successful in the Battle of Britain in which the Germans continued to use normal army types of ammunition, that the scheme was enlarged to embrace the requirement of air to ground and air to sea combat. Our designs were later adopted by the American Government.

This is typical of the co-operation constantly maintained between Britain and the U. S., both through the British Air Commission in Washington—which has on its staff experts who are kept constantly informed of developments in Britain and in turn keep us in touch with developments proceeding in the United States; and through the technical attaches of the United States services at the Embassy in London.

Much remains to be done, but a very remarkable degree of standardisation between the two great nations has certainly been achieved in a surprisingly short time. We must continue to work closely together for only thus can the maximum technical progress be achieved.

END

American Aircraft

(*Continued from page* 161)

ground. Four days later a *Fortress* dropped a load of bombs on Emden in daylight. Kiel, Bremen, Rotterdam, Cologne, as well as Bengazi and other towns in the Middle East, have also been attacked by the huge Boeing bombers.

Grumman *Martlet* fighters have proved their worth among naval aircraft in the Middle East, their first successes being recorded as far back as Christmas, 1940. The Vought-Sikorsky *Chesapeake* is another naval aircraft. The little Piper *Cubs* and Taylorcrafts, originally designed as "honeymoon planes" which could be parked in the back garden, have now put on their warpaint and are being used as trainers. Several other American types are destined for the RAF, including the new *Bermuda*, a Brewster aircraft, as was the famous *Buffalo* (variously known as the "Peanut Special" or "Flying Barrel") which was used in the Far East.

In the early days of the war, American aircraft were shipped to Britain by freighter. After the collapse of France and Belgium, large numbers of aircraft ordered by our Allies were diverted to Britain. It was soon found possible for ferry service pilots to fly bombers to Britain—and as a more recent development they are now flown direct to their destinations.

While operational and climatic conditions have called for frequent alterations and adaptations in their armament and equipment, the adaptability and versatility of American 'planes—notably the Douglas DB-7 series—has made them invaluable.

The peak of American aircraft production has not yet been reached. But the day is already in sight when American planes, with American pilots and crews, will be taking their place in full strength alongside the RAF in the greatest air offensive in history.

END

Eagle Squadrons

(*Continued from page* 145)

The third Eagle squadron, with which Flight Lieutenant McColpin has added two more enemy aircraft destroyed to his total, became one of Fighter Command's front line squadrons in April of this year, after already destroying a Dornier 217 which was attacking a convoy. They have since destroyed five German fighters on offensive sweeps. Two of these fell on one operation to Flt. Sgt. C. W. Harp, of Columbia, Ga.

END

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Air-Sea Rescue

(*Continued from page 154*)

used for a rescue is more often than not dictated by the weather and by the distance that craft has to travel. Thus in calm weather a high-speed launch can operate with success and despatch. In heavy weather, however, a craft of more solid construction and therefore of slower speed has to be used; and in violent storms recourse must be had to the lifeboat service or to slow-moving trawlers. Generally speaking, the farther out a rescue has to be made the more difficult is the problem that the naval authorities have to face. Moreover, the number of light craft is limited. This is a question of supply. The number of slipways, the number of men and the amount of material available for the construction of light craft is limited. Their crews have to be trained. Facilities for repair and refitting have to be provided. The position and size of the harbours they use must be considered. All these are limiting factors, but perhaps the problem which exercises the rescue service more than any other is the disposition of their craft. It is, for example, useless to put all the high-speed craft in one place and all the medium and slow-speed craft in another. They have to be mixed in the most economical and at the same time the most efficient proportions. The "density" area, that is to say the place where the largest number of rescues will probably have to be effected, must be plotted.

The Directorate of Air/Sea Rescue Services established at the end of 1940, has, since then, grappled with all these problems, and under its guidance the service has steadily improved in efficiency. It has the best of incentives—a high purpose—the saving of valuable lives and its members derive constant stimulus and encouragement from the steadily mounting total of rescues.

END

Ceylon

(*Continued from page 96*)

becomes imminent. The coming of this phase will confront the Japanese with the dual problem of keeping the Allied forces as far as possible from their "great wall," and of withdrawing forces from their own garrisons along that line so as to strengthen their vulnerable northern fronts.

The more the tide turns against the Japanese, the more imperative will be the necessity for them to conquer and use Ceylon. Evacuation of the overseas land forces from the Indies is practicable only if the waters of the South China Sea can be kept clear of Allied ships and aircraft. The taking of Ceylon would offer Japan the best means of ensuring this.

The Ceylon garrison will deny these great advantages to the Japanese. Daily the RAF in Ceylon is growing in strength, by reinforcement and increased efficiency within itself and by the development in every man of a sterner will and harder resolution.

END

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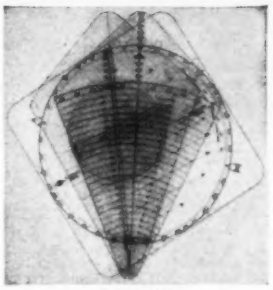

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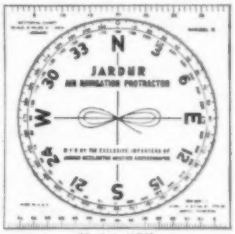

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Salon Data

"KNIGHT of the Air" shows a typical RAF fighter pilot standing on the engine cowl of his four-cannon Hawker **Hurricane.** He is wearing his parachute and "Mae West"; his helmet contains built-in earphones and the mouthpiece incorporates a built-in microphone and oxygen intake.

The tail wheel of the attacking British Bristol **Blenheim** bomber can be seen at the top of "Visit to Vaagso." This striking action photograph was taken during the course of a low-level surprise attack on the German-occupied Norwegian air base. Bombs can be seen bursting among the buildings.

"Tin Fish" shows a giant torpedo being slid into the belly of a Coastal Command Bristol **Beaufort** torpedo bomber. **Beauforts** and their deadly loads are the terror of enemy shipping.

One of the fuselage gunners in a Short **Sunderland** four-engined flying boat is the subject of "On Guard." The gun is a flexible .303 caliber machine gun.

"Hunter's Shadow" shows a low-flying **Sunderland** on the hunt for enemy submarines.

The four-engined giant in "Germany Bound" is a short **Stirling.**

"Bundle for Berlin" is one of the 1,000-pound bombs carried by the **Stirling.**

The four-gun tail turret in a **Sunderland** is featured in "Sting in the Tail."

"Storm Brewing" shows a **Spitfire** pulling up on the tail of the camera plane.

The Lockheed **Hudson** in "Iceland Patrol" is the airplane donated to the RAF by Lockheed and Vega employes.

The photograph on the front cover, taken by the Air Ministry, shows the ground crew preparing a Short **Stirling** bomber for an operational flight.

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(*Continued from page 270*)

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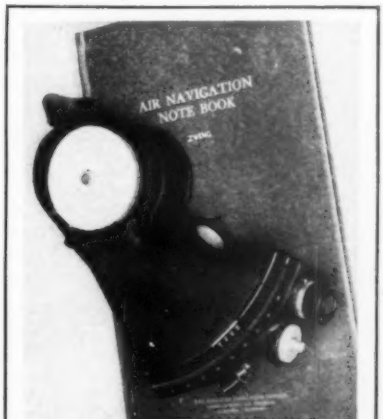

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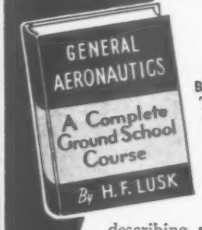

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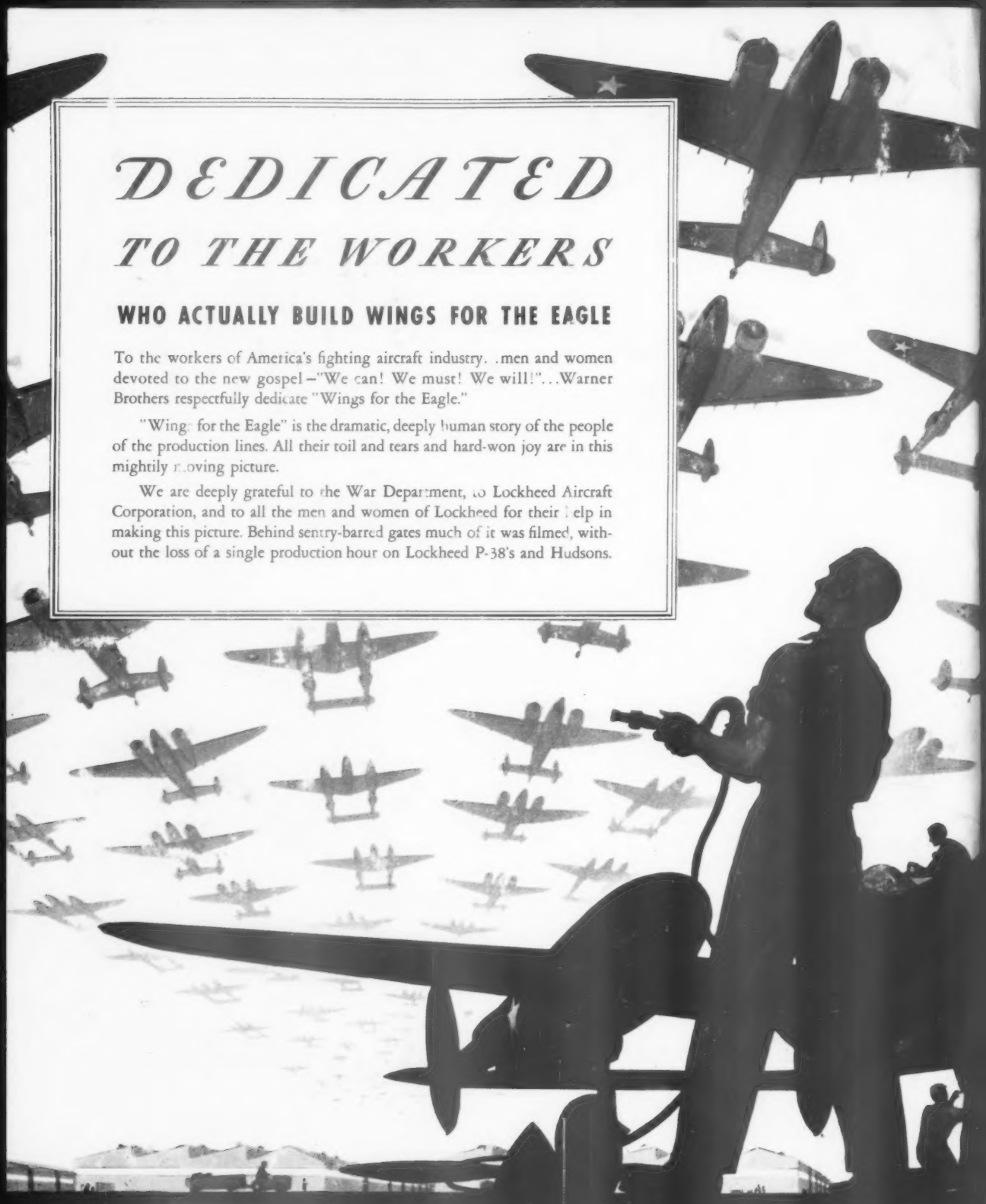

DEDICATED
TO THE WORKERS

WHO ACTUALLY BUILD WINGS FOR THE EAGLE

To the workers of America's fighting aircraft industry. .men and women devoted to the new gospel—"We can! We must! We will!"...Warner Brothers respectfully dedicate "Wings for the Eagle."

"Wings for the Eagle" is the dramatic, deeply human story of the people of the production lines. All their toil and tears and hard-won joy are in this mightily moving picture.

We are deeply grateful to the War Department, to Lockheed Aircraft Corporation, and to all the men and women of Lockheed for their help in making this picture. Behind sentry-barred gates much of it was filmed, without the loss of a single production hour on Lockheed P-38's and Hudsons.

WARNER BROS. HAVE THE HONOR TO OFFER AS THEIR NEWEST CONTRIBUTION TO THE AMERICAN SCREEN AND WAR EFF

WINGS FOR THE EAGLE

WITH ANN SHERIDAN ★ DENNIS MORGAN ★ Jack Carson ★ Geo. Tobias ★ Directed by Lloyd Bacon

WAR EFF
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